

Contract Language Guidelines For Acquiring Geospatial Data (CADD, GIS,CAFM) System Deliverables From Architect- Engineer (A-E) Consulting Firms

Updated Final Draft

Release 3.0

Approved For Public Release; Distribution Is Unlimited

Published by U.S. Army Engineer Research and Development Center

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Preface

Contract Language Guidelines For Acquiring Geospatial Data (CADD, GIS, CAFM) System Deliverables From Architect-Engineer (A-E) Consulting Firms is an update and consolidation of two reports originally prepared in 1998 by Department of Defense (DoD) Air Force, Army, and Navy personnel experienced in CADD, GIS technology, surveying and mapping requirements, installation mapping and management, and contracting procedures/requirements.

The preparation of the manual was funded through The CADD/GIS Technology Center for Facilities, Infrastructure, and Environment (The CADD/GIS Center) located at the Information Technology Laboratory (ITL), U.S. Army Engineer Research and Development Center (ERDC), in Vicksburg, MS. The manual was prepared under the direction of Dr. Jeffery P. Holland, Director, ITL, and Mr. Harold Smith, Chief, The CADD/GIS Center.

During the publication of this manual, Dr. James R. Houston was the Director of ERDC, and COL John W. Morris III was the Commander.

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

1 Introduction

Purpose

The purpose of this report is to provide guidelines and recommended contractual language for the preparation of Federal Business Opportunities (FedBizOpps) and contract documents to acquire the services of architect-engineer (A-E) consulting firms. Prior to January 1, 2002, bidding opportunities were posted on the Commerce Business Daily (CBD) site. The FedBizOpps web site (<http://www.FedBizOpps.gov/>) now represents the single government point-of-entry (GPE) for Federal government procurement opportunities over \$25,000.

This report specifically addresses the acquisition and delivery of geospatial data from computer systems (e.g., Computer-Aided Design and Drafting (CADD), Geographic Information System (GIS), Computer-Assisted Facility Management, (CAFM), and Automated Mapping (AM)) that employ or reference data using absolute, relative, or assumed coordinates. Types of products produced from these systems include:

- GIS drawings/maps
- Engineering CADD drawings for vertical (building) construction
- Facility management drawings/maps
- Master planning drawings/maps
- Environmental compliance drawings/maps
- Hydrographic surveys of rivers, ports, open ocean, bays, channels, and lakes
- Topographic mapping
- Drawing/map conversion, raster scanning/vector conversion
- High-order geodetic control (horizontal and vertical) surveys using a differential Global Positioning System (GPS) and conventional survey techniques, for control and property/boundary surveys
- Controlled and non-controlled aerial photography and photo processing
- Photogrammetric mapping including aero-triangulation
- Finish map (color and black-and-white) publishing or production from GIS datasets and software applications
- Digital-orthophotography image file and map production
- Remote sensing, radar, and satellite imagery
- Large-format map and/or aerial imagery document production

Future Additions and Updates

The contents of this document are intended to be neither static nor all-inclusive and are updated and enhanced as appropriate. Recommendations or additions should be sent to The CADD/GIS Technology Center (CEERD-ID), ATTN: Mr. Toby Wilson, U.S. Army Engineer Research and Development Center, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199 (E-mail: james.t.wilson@erdc.usace.army.mil).

Electronic copies of this document may be obtained from The CADD/GIS Technology Center's internet homepage at <http://tsc.wes.army.mil>.

Applicability

The guidelines and sample contract language in this document are applicable to all Department of Defense (DoD) technical personnel involved in the acquisition of A-E services for preparing and delivering geospatial data products.

Background

The CADD/GIS Technology Center

In 1992, the Military Construction Council recognized the cost-effectiveness of consolidating CADD and GIS program activities into a single agency. The establishment of a single organization responsible for data content standards eliminates redundant efforts and provides a cohesive approach to standards development typically seen only in large, single-purpose corporations. With this goal in mind, personnel with expertise in CADD and GIS were assembled to form the CADD/GIS Technology Center for Facilities, Infrastructure, and Environment (The Center).

The Center is under the administration of the U.S. Army Engineer Research and Development Center, Information Technology Laboratory (ITL), Vicksburg, MS. The Center develops CADD and GIS data standards, promotes system integration, supports centralized acquisition of equipment and software, and provides assistance for the installation, training, operation, and maintenance of CADD/GIS and facilities management (FM) systems. This also includes directing specific application developments, promoting communications, developing and promoting standards, furnishing technical advice, interfacing with professional organizations and industry, evaluating technological developments, and recommending necessary CADD, GIS, and FM policies.

Target Technologies

Computer-Aided Design and Drafting (CADD)

CADD technology has become the preferred method for the preparation, distribution, storage, and maintenance of architectural and engineering type drawings. With basic CADD systems, three-dimensional or two-dimensional graphics are placed on various drawing layers that can be selectively displayed and edited.

Advanced CADD-based application packages assist in the performance of specialized design or analytical functions such as highway design, site design, architectural design, and survey/mapping. Some products store attribute data with existing graphic elements. Others provide linkages between graphic elements and data in external files or external databases.

Geographic Information System (GIS)

GIS technology provides a computerized mechanism for capturing, verifying, storing, manipulating, querying, analyzing, and displaying geospatial data referenced to their location on earth. Most current GIS combine the use of CADD and Relational Database Management System (RDBMS) technologies to relate data to features on digital maps and drawings. The newest GIS eliminates the CADD component in favor of an internal graphics engine integrated with an object-oriented relational database.

Image Processing (IP) and Automated Mapping (AM)

IP and AM are computer graphic technologies that produce maps (e.g., the conversion of manual maps to digital maps by digitizing). IP and AM provide the capability to develop high-quality maps, and typically have limited database management system (DBMS) capability. IP and AM differ from CADD in that they focus on providing high-quality drafting and cartographic capabilities, and do not offer a comprehensive set of engineering design functions to the user.

Computer-Assisted Facility Management (CAFM)

A CAFM system permits the linkage of digital drawings with a DBMS in a manner that permits both the manipulation and query of database information and the graphic display of information needed for the management of buildings, roads, and other components of an organization. In a CAFM system, the emphasis is placed on data storage, analysis, and reporting (in both text and drawings) capabilities. Typical functions include:

- long-range and annual facility planning
- facility financial forecasting
- real estate acquisition and/or disposal

- work specifications, installation and space management
- architectural and engineering planning and design
- new construction and/or renovation
- maintenance and operations management
- telecommunications integration
- security
- general administrative services

The production and graphic presentation of drawings does not require the precision or detail of an IP system, but it is still an important consideration. Both CADD-based and GIS-based software programs can be used to accomplish CAFM functions.

Land Information Systems (LIS)

An LIS may be briefly defined as an on-line repository of information that relates land use practices to individual landholdings and their owners. LIS typically contains agricultural, soil, irrigation, demographic, climatic, meteorological and elevation information, in addition to the graphical sketches depicting land holding, ownership, and related information.

Remote Sensing

Remote sensing systems acquire information about the Earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information. Techniques involve measuring force fields, electromagnetic radiation, or acoustic energy employing cameras, radiometers and scanners, lasers, radio frequency receivers, radar systems, sonar, thermal devices, seismographs, magnetometers, gravimeters, scintillometers, and other instruments.

Computerized Maintenance Management Systems (CMMS)

CMMS rely primarily on database systems to provide facility management capabilities. Typically, a CMMS does not incorporate graphic display or digital drawings as a component of the system. CMMS's focus on inventory control, maintenance (both preventive and emergency), infrastructure, and utilities.

Database Management System (DBMS)

A database consists of a structured and organized collection of information. A DBMS's purpose is to maintain information and to make that information available on demand. A relational DBMS (RDBMS) is a computer program that provides a means of managing the related data contained in one or more database tables. A newer DBMS called "object-oriented" is a DBMS that manages abstract

representations of real-world entities that have embedded data manipulation properties. Object-oriented is poised to become the dominate DBMS in both CADD and GIS.

The computer language which has been developed for organizing, managing, interacting, and retrieving the data stored in a RDBMS is called Structured Query Language (SQL). SQL is an integral part of a RDBMS and provides the following functions:

- *Data Definition* - The organization and structure of the data and the relationships between the data can be defined by the user
- *Data Retrieval* - Stored data can be retrieved from the database and used by the user or an application program
- *Data Manipulation* - The user of an application program can update the database by adding new data, removing old data, and modifying previously stored data
- *Access Control* - A user's ability to retrieve, add, and modify data can be restricted, thereby protecting stored data against unauthorized access
- *Data Sharing* - Data shared by concurrent users can be coordinated, thereby ensuring that they do not interfere with one another
- *Data Integrity* - Integrity constraints in the database can be defined, thereby protecting it from corruption due to inconsistent updates or system failures

The American National Standards Institute (ANSI) and the International Standards Organization (ISO) first published standards for SQL in 1986, which were then expanded in 1992. SQL is also included in the U.S. Federal Information Processing Standards (FIPS).

Data Standards

It has become DoD policy to acquire deliverables from A-E's to maximize the use of electronic digital data. To further improve the use of digital data and to have the capability to share databases within the DoD, graphic and non-graphic standards must be adopted.

Geospatial Data Standards

The term "geospatial data" is used in this report as an encompassing term that refers to data referenced (directly or indirectly) to a location on the earth's surface and is characterized by natural or man-made features.¹ Geospatial data products are critical for life-cycle management of an organization, from planning through facilities management to disposal. To maintain quality/consistency and have the capability to share database information, standards must be mandated

¹ For convenience, terms and abbreviations are listed in Appendix F.

for both graphic and non-graphic information. Standards for geospatial data ensures that:

- The data gathered and created in one life cycle management phase (e.g., planning) are readily usable in subsequent phases (e.g., facility management or disposal)
- The digital drawings, maps, and geospatial data are applicable for their intended use
- The digital drawings, maps, and geospatial data are compatible with the available CADD and GIS equipment and software
- The digital drawings, maps, and geospatial data created for one project, or project discipline, are compatible with those created for other similar projects
- The digital drawings, maps, and geospatial data can be transferred and integrated with other applications, such as cost estimating, specification development, facility management, and environmental management and compliance
- The digital drawings, maps, and geospatial data generated at one organization will comply with the same graphic and non-graphic standards as those developed by another
- The compatibility of the geospatial data with pertinent national, international, and industry standards is maintained

Content Standards for Digital Geospatial Metadata

The ability to use existing geospatial data is important to individuals in various organizations who are trying to share data. Metadata or “data about data” is the key to developing this ability. Metadata describes the content, quality, condition, and other characteristics of geospatial data.

Office of Management and Budget (OMB) Circular No. A-16 (1990), entitled “Coordination of Surveying, Mapping, and Related Spatial Data Activities,” established an interagency coordinating committee known as the Federal Geographic Data Committee (FGDC), whose objective is to promote the coordinated development, use, sharing, and dissemination of surveying, mapping, and related geospatial data. OMB Circular No. A-16 also established a process to promote the development of a national spatial framework for an information-based society with the participation of Federal, state, and local governments, and the private sector, in order to reduce duplication of effort.

The FGDC has been charged with the responsibility of developing standards for the format and content of geospatial metadata. These standards are known as the FGDC Metadata Standard.

Executive Order 12906, “Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure,” which was signed by President Clinton on 11 April 1994, requires that all Federal agencies use the FGDC Metadata Standard to document new geospatial data and make them electronically accessible through the use of a National Geospatial Data Clearinghouse.

The Clearinghouse is intended to be a distributed, electronically connected network of geospatial data producers, managers, and users. When fully functional, the Clearinghouse will allow its users to electronically (via the Internet) determine what geospatial data exist, find the data they need, evaluate the usefulness of the data for their applications, and obtain or order the data as economically as possible.

Information concerning the FGDC can be obtained from the FGDC Internet homepage at <http://www.fgdc.gov>.

Recommended Provisions for Acquisition of A-E Consultant Contract Services

To acquire the services of A-E consulting firms, Government agencies are required to follow the procedures defined in Federal Acquisition Regulation (FAR), Part 36.6. Additional requirements for the DoD are included in Part 236 of the DoD FAR supplement (DFAR). In 1972, Congress enacted Public Law 92-582 (called Brooks Bill) which defines A-E services, states how prospective contract awards are to be announced, and clarifies the procedures for selecting A-E’s and negotiating their contracts.

A-E contracts are typically the firm fixed-price, cost-reimbursement, or the indefinite delivery order type. The firm fixed-price contract includes a price ceiling limiting the financial obligation of the Government to the contractor for satisfactory completion of the contract, and the contractor guarantees completion of a specified product. In the negotiated firm fixed-price contract, the A-E contractor agrees to accept all risks and provide the specified product for the stated fixed price. The A-E assumes full responsibility (in the form of profits or losses) for all costs under or over the firm fixed-price that are incurred during the process of completing the work specified under the contract. No adjustment in the price is made unless the scope of work is modified by the Government’s Contracting Officer.

The cost-reimbursement contract provides for reimbursing the contractor for all (or, on occasion, a portion of) costs incurred in the performance of the contract to the extent specified in the contract. The cost-reimbursement contract includes an estimate of total cost for the purpose of obligating funds and establishing a cost ceiling that the contractor may not exceed without prior approval of the Government Contracting Officer. The contractor agrees, but does

not guarantee, to do his best to complete the specified product within the cost ceiling.

Indefinite delivery order contracts are used where there will be a recurring demand for certain types of work, but the timing and/or full extent of the demand are not certain. In other words, the general types of work that will be required are known, but the full scope and the specific project details are not known at the time of contract award. The contract establishes fixed hourly rates for the disciplines of personnel and other related items that are required. The contract also contains detailed administrative and technical contract provisions for the development and delivery of the types of work to be accomplished under the contract. Cost and time limits, which cannot be exceeded, are included in the contract. The Government assigns work to the A-E contractor through the award of individual delivery orders.

USACE guidance and regulations which are applicable to A-E contracting, and which can be used as guidance for all DoD organizations, can be found in:

- USACE Engineer Pamphlet, EP-715-1-7, **Procurement - Architect-Engineer Contracting**

The procurement process for a typical A-E consulting services contract begins with the placement of an initial advertisement containing project selection criteria on the Federal Business Opportunities (FedBizOpps) web site (<http://www.FedBizOpps.gov>).

Consulting firms that respond to the advertisement (i.e., Standard Forms 254 and 255) are evaluated by a selection board. Some organizations have a pre-selection board for preliminary evaluation and ranking of the firms. The firms are ranked based upon qualifications and experience, with the detailed administrative and technical contract provisions outlined in the synopsis on FedBizOpps. Announcement of selection is sent to the firm with the highest ranking, along with a request for proposal. An agreement is negotiated with the selected firm, and the consulting contract is awarded.

Clearly understood requirements and terminology must be included in the contract technical provisions to ensure that maps are prepared in accordance with Geospatial Data Systems (GDS) standards. This is generally accomplished in the following steps:

1. The requirement to acquire geospatial-related data, engineering drawings, develop maps, and deliver the maps and geospatial-related data in a digital format using GDS technology must be included in the FedBizOpps announcement.

2. The more detailed geospatial data acquisition, preparation, and delivery instructions must be included in the technical contract provisions.

Sample clauses for inclusion in FedBizOpps announcements and the technical contract provisions requiring the use of GDS technology in acquiring geospatial data, preparing maps, and delivering geospatial data are included in Appendices A through D of this manual.

2 Geospatial Data Acquisition and Mapping Criteria

Introduction: Geospatial Data Systems (GDS)

Geospatial data systems (GDS) consist of any automated system that employs data referenced to a location on the earth. The following criteria and standards are intended to promote consistency in the development and use of specifications for the acquisition and mapping of geospatial data. Geospatial data acquisition and mapping includes traditional surveying and mapping, aerial photography, remote sensing, Global Positioning Systems (GPS), and map scanning and vectorization. Much of the technical guidance contained herein reflects updated criteria and standards resulting from technological advancements in photogrammetry, CADD, GIS, and GPS surveying and mapping.

Available technical guidance in preparing specifications is presented by reference to industry standards, and DoD technical regulations and manuals. Further guidance includes use of standards being promulgated by the CADD/GIS Technology Center and the FGDC.

General Policy Guidance

Construction plans, maps, CADD, and GIS databases are created by a variety of terrestrial, satellite, acoustic, and aerial mapping techniques that acquire planimetric, topographic, hydrographic, or feature attribute data.

Specifications for obtaining these data should be “performance-based” to the maximum extent possible and not overly prescriptive or process oriented. They should be derived from the project requirements, and industry standards should be used where available. Performance specifications should distinctly define the basic mapping limits, feature location, attribute requirements, scale, contour interval, map format, sheet layout, final data transmittal, metadata, archiving or storage requirements, and the required accuracy criteria standards for topographic and planimetric features that are to be depicted. Prescriptive specifications should be kept to a minimum--in particular, those that require use of specific instruments, procedures, and personnel.

Sources of geospatial data acquisition services

Geospatial data may be acquired using either in-house or contracted labor. Determining whether to use contracted support is a function of in-house survey capabilities and current workload. In general,

in-house forces are reserved for critical, fast-track projects and construction measurement, payment, and acceptance surveys where rapid response is essential. Surveying and mapping projects are contracted using fixed-price or indefinite delivery A-E contracts specific to these services. As stated in Chapter 1, the Brooks Bill (PL 92-582) qualification-based selection process must be used in obtaining these services.

Industry standards

OMB Circular No. A-119, “Federal Participation in the Development and Use of Voluntary Standards,” prescribes that Federal agencies maximize use of industry standards and consensus standards established by private voluntary standards bodies, in lieu of Government-developed standards. The OMB circular encourages that voluntary industry standards be given preference over nonmandatory Government standards. When industry standards are nonexistent, inappropriate, or do not meet a project's or organization's functional requirement, then the appropriate Government standard may be specified.

Technical specifications for the acquisition of geospatial data (e.g., surveying and mapping) should conform to industry consensus standards established by national professional organizations, such as the American Society for Photogrammetry and Remote Sensing (ASPRS), the American Society of Civil Engineers (ASCE), the American Congress on Surveying and Mapping (ACSM), or the American Land Title Association (ALTA). FGDC standards and specifications may be used where they are clearly performance-oriented and not overly prescriptive. Technical standards established by state boards of registration, especially on projects requiring licensed surveyors, mappers, architects, engineers, etc. should be followed when legally applicable.

Performance specifications

Maximum use of performance-oriented (i.e., outcome based) specifications in procuring surveying and mapping services is strongly recommended. Performance specifications set forth the end results to be achieved (i.e., final map format or accuracy standard) and not the means or technical procedures used to achieve those results. A performance-oriented specification provides the most flexibility to a professional services contractor and allows the contractor to employ the most economical and efficient methods to achieve the desired end product. Performance-oriented specifications must be free from unnecessary equipment, personnel, instrumentation, procedural, or material limitations; except as needed to establish comparative cost estimates for negotiated services.

Performance specifications should simply delineate the area and type of features to be mapped, identify accuracy standards to be met, and describe Government-quality assurance procedures that will be used to verify conformance with the specified criteria. This would include any in-progress reviews or approvals during various phases of the project. To the maximum extent practicable, A-E contractors should be assigned all phases of a survey and mapping project--from “field to finish.”

Prescriptive (procedural) specifications

The use of prescriptive specifications should be kept to a minimum and be required only on highly specialized or critical projects where only one prescribed technical method, in the opinion of the Government, is appropriate or practical to perform the work. Prescriptive specifications typically require specific field instrumentation, equipment, personnel, office technical production procedures, or

rigid project phasing with on-going design or construction. Prescriptive specifications may (depending on the expertise of the writer): (1) reduce a contractor's flexibility, efficiency, and risk; (2) increase significantly the Government's liability and risk; and (3) increase project costs if antiquated methods or instrumentation are required.

Prescriptive specifications may be applicable to DoD projects or facilities involving specialized work not routinely performed by private surveying and mapping firms (e.g., mapping tactical operation sites; mapping hazardous, toxic, and radioactive waste (HTRW) clean-up sites; etc.).

Quality control

Quality control (QC) of contracted services should be performed by the contractor. Therefore, Government quality assurance (QA) and testing functions should be focused on whether the contractor meets the required performance specification (e.g., map accuracy) and not the intermediate surveying, mapping, and compilation steps performed by the contractor. The contractor's internal QC will normally include independent tests which should be periodically reviewed by the Government. Government-performed (or monitored) field testing of map accuracy is an optional QA requirement and should be performed only when technically and economically justified, as determined by the ultimate project function. Few mapping projects warrant extensive Government testing or inspection during progress.

Installation Maps

The term “map” refers to a two-dimensional graphic image, which shows the location of things in space (i.e., in relationship to the Earth's surface). A typical map uses an orthogonal viewpoint - where every point on the map is viewed as if looking straight down from above - to represent the Earth's three-dimensional surface onto a plane. It does not describe or depict individual features, but represents them by symbols (e.g., points, lines, polygons, area patterns and colors etc.), that place them into classes or categories. Maps are the most common graphic used for installation planning.

Map scales

Scale is used to establish the relationship between the distance of two points on the earth and the distance between two corresponding points on the map. As a rule, scale is referred to as a numerical ratio of map distance to ground distance. It is usually written as 1/24,000 or 1:24,000, meaning that one unit of measurement on the map represents 24,000 of a particular unit on the ground. Maps should be prepared at a scale appropriate for the information or subject being illustrated. When scale is expressed in words, for example one inch equals 50 feet, it is referred to as a verbal scale. The bar scale or visual scale can be used for measuring distance. It graphically displays the relationship between map distance and ground distance.

Specialized needs

The ability to use a common set of installation maps and geospatial data to plan, design, build/construct, operate, and maintain DoD facilities requires that guidelines and standards be rigorously employed in the preparation of maps that can support an installation's multidiscipline analysis environment. That environment is driven by specialized needs such as:

- Mission requirements

- Installation master/comprehensive planning
- National Environmental Policy Act (NEPA) reporting
- Installation restoration program management
- Natural and cultural resource management
- Site planning and concept design
- Construction management
- Mobilization planning
- Environmental compliance
- Emergency response
- Range management
- Facilities management
- Work order management
- Privatization of installation functions
- Base closure

DoD enterprise-wide approaches

Several initiatives are underway to perform research and development of viable methods and products or tools for developing and maintaining maps and other spatially referenced data to serve an installation's diverse informational needs. Considerable effort is expended in the identification of enterprise-wide solutions - where data collected once can be used by many. A few of the significant organizations researching and/or developing guidance for mapping and geospatial data maintenance within the DoD include the U.S. Air Force Center for Environmental Excellence (AFCEE), The CADD/GIS Technology Center, and the U.S. Navy's Naval Facilities Engineering Command (NAVFACENGCOM).

AFCEE develops information and provides resources and services related to Air Force-wide environmental, architectural, landscape design, planning, and construction management. AFCEE has developed excellent on-line guidance for the preparation of the Installation General Plan at the Internet address <http://www.afcee.brooks.af.mil>. The site addresses some aspects of the development of the Air Force map series associated with installation planning and operations. Through the use of standardized planning documents and the development of tools to facilitate the standardization, the Air Force is taking an important step toward the preparation of usable spatial data on an enterprise-wide basis.

The CADD/GIS Technology Center offers CADD, GIS and FM standards. These products are available at the Center's Internet site at the following address: <http://tsc.wes.army.mil/>. The Center's FM Standard is being developed to expand upon the GIS Spatial Data Standard for facilities, infrastructure and environment (SDSFIE) to address work order management, environmental restoration tasks and environmental sampling, and other installation maintenance processes and functions that are not typically modeled through graphical depiction within a GIS.

NAVFACENGCOM has initiated Vanguard, an intranet to provide access to NAVFACENGCOM business and facilities information for all NAVFACENGCOM employees. NAVFACENGCOM plans to expand access to its customers and suppliers through an extranet. One Vanguard initiative is the mapping process. The goals of this initiative are to develop a NAVFACENGCOM corporate strategy for preparing and maintaining Navy activity maps and to provide base maps of Navy installations to customers via the Internet.

Necessary installation maps

Installations are guided by their respective service's comprehensive or master planning requirements. Each installation, depending on its mission, may have substantially more or fewer theme specific maps. It is the responsibility of the installation's planning, environmental operations, engineering, and administrative staff to understand the mapping needs for their installation. Each installation is unique and the specific quantity and type of maps required for an installation depend upon its individual features, conditions, and requirements. An installation will generally produce and maintain a set of maps to meet both its planning and operational needs.

Notwithstanding the various maps required by each DoD service to meet their unique and respective planning requirements, the references to the maps are also generally unique. The development of common terms of reference for map products is necessary to move toward the standardization of installation mapping. Once an accepted common mapping vocabulary is established, similarities in planning requirements will emerge. A glossary of common terms is included in Appendix H.

Table 2-1, Recommended Installation Maps, provides a list of common installation maps. Included in the table is the map name, whether the map is a mandatory or optional product as a part of the component or element plan, map scale, accuracy requirement, contour intervals, and a description of the map and its common features.

Table 2-1 Recommended Installation Maps					
NOTE: UNLESS OTHERWISE SPECIFIED THE INSTALLATION LAYOUT MAP WILL BE USED AS THE BASIS FOR THE PREPARATION OF OTHER SPECIFIED MAPS.					
MAP AND GRAPHIC LAYERS <i>M=mandatory</i> <i>O=optional</i> <i>TBD=to be determined</i>		MAP SCALE 1"=xxxx'	MINIMUM MAP CLASS- ACCURACY	CONTOUR INTERVAL (feet)	DESCRIPTION AND FEATURES SHOWN
A- NATURAL AND CULTURAL RESOURCES A-1 AREAS OF CRITICAL CONCERN	M	1"=400' 1:4,800	Class 3	5	Shows historic and archeological sites, areas of threatened and endangered species, primary habitat areas, flood plains, wetlands, coastal zones, lakes, rivers, water bodies, soils and soil boring locations, and similar information.
A- NATURAL AND CULTURAL RESOURCES A-2 MANAGEMENT AREAS	O	1"=400' 1:4,800	Class 3	5	Shows surface/subsurface geology, paleontology, topography, hydrology and surface drainage, vegetation areas, forests, commercial timber areas, agricultural outleasings areas, fish and wildlife areas, prime soils, grounds maintenance areas, outdoor recreation areas, pest management areas, and similar information.
B- ENVIRONMENTAL QUALITY B-1 ENVIRONMENTAL REGULATORY AREAS	M	1"=400' 1:4,800	Class 3	5	Shows hazardous waste generation points, hazardous waste storage facilities, solid waste disposal and recycling points, fuel tanks, Resource Conservation and Recovery Act sites, installation

Table 2-1
Recommended Installation Maps

NOTE: UNLESS OTHERWISE SPECIFIED THE INSTALLATION LAYOUT MAP WILL BE USED AS THE BASIS FOR THE PREPARATION OF OTHER SPECIFIED MAPS.

					restoration program sites/areas, and similar information.
B- ENVIRONMENTAL QUALITY B-2 ENVIRONMENTAL EMISSIONS AREAS	O	1"=400' 1:4,800	Class 3	5	Shows sources of air emissions, wastewater Non-point Pollution Discharge Elimination System (NPDES) point source discharges, storm water non-point discharges, drinking water supply, electromagnetic radiation sources, sources of radon emissions and similar information.
C-INSTALLATION LAYOUT AND VICINITY C-1 INSTALLATION LAYOUT	M	1"=100' 1:1,200	Class 3	2	Shows the installation boundary; buildings (facility identification numbers and type: permanent, semi-permanent, temporary); structures; roads and parking areas; walkways and trails; railroads; fences; recreation areas; cemeteries; training ranges; contours; water areas; coordinate grid; embankments; below/above ground tanks; embankments; spot elevations and survey control; neighboring land use (outside installation boundary); historic buildings and places, archeological sites and similar information.
C-INSTALLATION LAYOUT AND VICINITY C-2 OFF-INSTALLATION SITES	M	1"=400' 1:4,800	Class 3	5	Shows the same information as the installation layout map, but this map is prepared for those facilities that are outside the installation's primary boundary.
C-INSTALLATION LAYOUT AND VICINITY C-3 INSTALLATION REGIONAL LOCATION	O	1"=2,000' 1:24,000	NA	20	Shows information of interest to regional planning and major transportation systems, cities, towns, political jurisdictions, DoD installation boundaries, aeronautical data, woodlands, recreation areas, towers, significant physical characteristics of the region and other similar information.
C-INSTALLATION LAYOUT AND VICINITY C-4 INSTALLATION VICINITY	O	1"=1000' 1:12,000	Class 3	10	Shows the installation boundary, airfield and operations areas, major roads, proposed roads and highways, railroads, bombing and test ranges, vertical obstructions, topography, recreation areas, waterways and bodies, towers and similar information.

Table 2-1
Recommended Installation Maps

NOTE: UNLESS OTHERWISE SPECIFIED THE INSTALLATION LAYOUT MAP WILL BE USED AS THE BASIS FOR THE PREPARATION OF OTHER SPECIFIED MAPS.

C-INSTALLATION LAYOUT AND VICINITY C-5 AERIAL PHOTOGRAPHIC COVERAGE AND CONTROL STATIONS	O		NA	NA	Prepared as an index of the aerial photographic coverage for the installation, shows the center point of individual photographs as well as the location of survey control stations and control points used for the aerial photography.
C-INSTALLATION LAYOUT AND VICINITY C-6 INSTALLATION BOUNDARY	M	Legal Records	Class 3	1	Shows the land area comprising the installation boundary including survey monuments.
D- LAND USE D-1 INSTALLATION LAND USE D-1.1 FUTURE LAND USE	M	1"=400' 1:4,800	Class 3	5	Shows installation land use including airfields; maintenance and repair areas; manufacturing industrial areas; supply/ storage areas; administration areas; training and ranges areas; troop and family housing; community facilities (commercial and service); medical facilities; outdoor recreation; open spaces; and similar information
D- LAND USE D-2 OFF SITE LAND USE D-2.1 FUTURE OFF SITE LAND USE	O	1"=400' 1:4,800	Class 3	5	Shows off-site land use including airfields; maintenance and repair areas; manufacturing industrial areas; supply/ storage areas; administration areas; training and ranges areas; troop and family housing; community facilities (commercial and service); medical facilities; outdoor recreation; open spaces; and similar information
D- LAND USE D-3 REAL ESTATE	O	1"=400' 1:4,800	Class 3	2	Shows the land area comprising the installation including parcel information on fee title, lease, license, permit and easement areas inclusive of tract, acreage, data of acquisition, lease period and similar information.
D- LAND USE D-4 EXPLOSIVE SAFETY QUANTITY-DISTANCE CLEARANCE ZONES (QD-ARCS)	M	1"=400' 1:4,800	Class 3	5	Same as installation layout map, but includes the distance clearance zones for explosives.
D- LAND USE D-5 HAZARD ANALYSIS CONSTRAINTS	M	1"=400' 1:4,800	Class 3	5	Same as installation layout map, but includes areas of catastrophic potential to include flooding, subsidence, avalanche, erosion, earthquake, tsunami, snowfall, windstorm, volcanic ash and similar information.
D- LAND USE D-6 COMPOSITE CONSTRAINTS	M	1"=400' 1:4,800	Class 3	5	Same as installation layout map, but emphasizes areas of catastrophic potential from natural occurrences e.g., flooding, subsidence,

Table 2-1
Recommended Installation Maps

NOTE: UNLESS OTHERWISE SPECIFIED THE INSTALLATION LAYOUT MAP WILL BE USED AS THE BASIS FOR THE PREPARATION OF OTHER SPECIFIED MAPS.

					avalanche, earthquake, tsunami and technological occurrences, accident potential zones, hazardous noise areas, noise contours, environmental management areas and other similar information.
D- LAND USE D-7 AREA DEVELOPMENT	O	1"=100' 1:1,200	Class 3	2	Same as installation layout map, but includes information on the planned development of areas within the installation.
E-AIRFIELD OPERATIONS 1 ON-BASE OBSTRUCTIONS TO AIRFIELD CRITERIA	E- M	1"=1,000' 1:12,000	Class 3	5	Same as airport pavement map and includes information on any obstructions to navigation and ground movement of aircraft within the installation boundary.
E-AIRFIELD OPERATIONS 2 APPROACH/DEPARTURE ZONE OBSTRUCTIONS (to 10,000 feet)	E- M	1"=800'	Class 3	5	Shows obstructions within the glide angle approach zone and other similar information within the distance specified.
E-AIRFIELD OPERATIONS E-3 APPROACH/DEPARTURE ZONE OBSTRUCTIONS (from 10,000 feet to 10 miles)	M	1"=2,000' 1:24,000	Class 3	10	Shows obstructions within the glide angle approach zone and other similar information within the distance specified.
E-AIRFIELD OPERATIONS 4 AIRSPACE OBSTRUCTION-VICINITY	E- M	1"=1,000' 1:12,000	Class 3	10	Shows obstructions within the vicinity of the airfield, but not those already shown on approach/departure zone maps, topography, cities, towns, other obstructions, water courses and water bodies and similar information.
E-AIRFIELD OPERATIONS 5 TERMINAL ENROUTE PROCEDURES (TERPS) AUTOMATION	E- M	TBD	TBD	TBD	Shows all NAVAIDS with latitude and longitude.
E-AIRFIELD OPERATIONS E-6 AIRFIELD/AIRSPACE CLEARANCES	O	1"=100' 1:1,200	Class 3	2	Shows airfield waivers, clear zones, primary surface, transitional surface (7:1), approach and departure surface (50:1) approach and taxiway clearances, wing tip clearances, turning radii, and other similar information necessary for aircraft movement on the ground.
E-AIRFIELD OPERATIONS E-7 AIRFIELD PAVEMENT	O	1"=400' 1:4,800	Class 3	5	Shows runways, taxiways, aprons, warm-up pads, hardstands, helipads, stabilized shoulders, overruns and similar information.
E-AIRFIELD OPERATIONS 8 AIRFIELD PAVEMENT DETAILS	E- O	1"=100' 1:1,200	Class 3	2	Shows runways, taxiways, aprons, warm-up pads, hardstands, helipads, stabilized shoulders, overruns and similar information, but includes cross sections and elevation profiles.

Table 2-1
Recommended Installation Maps

NOTE: UNLESS OTHERWISE SPECIFIED THE INSTALLATION LAYOUT MAP WILL BE USED AS THE BASIS FOR THE PREPARATION OF OTHER SPECIFIED MAPS.

E-AIRFIELD OPERATIONS 9 AIRCRAFT PARKING 9.1 PROPOSED AIRCRAFT PARKING	E- E- O	1"=100' 1:1,200	Class 3	2	Shows the parking plan for aircraft including alert hangars, refueling outlets, blast fences, aircraft orientation, control tower, fire station, cargo holding pads, maintenance docks, maintenance lights, aircraft revetments and similar information.
E-AIRFIELD OPERATIONS E-10 AIRFIELD LIGHTING SYSTEMS	O	1"=100' 1:1,200	Class 3	2	Shows the major components of airfield lighting system including runway, taxiway, end reference lights, location size and type of underground ducts, obstruction lights, stand-by generator equipment and similar information.
F- Reserved					
G-UTILITY SYSTEMS G-1 WATER SUPPLY SYSTEM	M	1"=50' 1:600	Class 3	1	Shows all significant components of the water supply system.
G-UTILITY SYSTEMS G-2 SANITARY SEWERAGE SYSTEM	M	1"=50' 1:600	Class 3	1	Shows all significant components of the sanitary sewerage system.
G-UTILITY SYSTEMS G-3 STORM DRAINAGE SYSTEM	M	1"=50' 1:600	Class 3	1	Shows all significant components of the storm drainage system.
G-UTILITY SYSTEMS G-4 ELECTRICAL DISTRIBUTION SYSTEM (STREET AND AIRFIELD)	M	1"=50' 1:600	Class 3	2	Shows all significant components of the electrical distribution and exterior lighting systems.
G-UTILITY SYSTEMS G-5 CENTRAL HEATING/COOLING SYSTEMS	M	1"=50' 1:600	Class 3	1	Shows all significant components of the central heating/cooling systems.
G-UTILITY SYSTEMS G-6 NATURAL GAS DISTRIBUTION SYSTEM	M	1"=50' 1:600	Class 3	2	Shows all significant components of the natural gas distribution system.
G-UTILITY SYSTEMS G-7 LIQUID FUEL SYSTEM	M	1"=50' 1:600	Class 3	1	Shows all significant components of the liquid fuel system.
G-UTILITY SYSTEMS G-8 CATHODIC PROTECTION SYSTEM	O	1"=100' 1:1,200	Class 3	2	Shows all significant components of the cathodic protection system for all underground utility systems and structures subject to electrochemical corrosion.
G-UTILITY SYSTEMS G-9 CATHODIC PROTECTION SYSTEM DETAILS	O	1"=50' 1:600	Class 3	2	Shows all significant components of the cathodic protection system including details of other utilities in proximity to ground beds for all underground utility systems.
G-UTILITY SYSTEMS G-10 INDUSTRIAL WASTE AND DRAIN SYSTEM	O	1"=50' 1:600	Class 3	2	Prepared when these systems are of such a complexity or nature it requires the production of a separate map to portray their characteristics.

Table 2-1
Recommended Installation Maps

NOTE: UNLESS OTHERWISE SPECIFIED THE INSTALLATION LAYOUT MAP WILL BE USED AS THE BASIS FOR THE PREPARATION OF OTHER SPECIFIED MAPS.

G-UTILITY SYSTEMS G-11 COMPOSITE UTILITY SYSTEM	M	1"=100' 1:1,200	Class 3	2	Shows the water, sanitary sewer, storm drainage, electrical, central heating/cooling, gas compressed air, industrial waste and other utility systems combined on a single map.
G-UTILITY SYSTEMS G-11.1 CENTRAL AIRCRAFT SUPPORT SYSTEMS	O	1"=50' 1:600	Class 3	2	Shows all the utilities systems that serve the airfield apron and related servicing of aircraft.
G-UTILITY SYSTEMS G-12 FIRE PROTECTION SYSTEMS AND UTILITIES	M	1"=400' 1:4,800	Class 3	5	Shows fire hydrants, water deluge systems, safety buffer distances, vehicle maneuverability areas, and similar information related to fire protection or safety.
G-UTILITY SYSTEMS G-13 OTHER UTILITY SYSTEMS	O	1"=100' 1:1,200	Class 3	2	Show utilities not displayed on other maps.
H-COMMUNICATION AND NAVAID SYSTEMS H-1 INSTALLATION-WIDE COMMUNICATIONS AND COMPUTER SYSTEMS	M	1"=400' 1:4,800	Class 3	5	Uses the installation layout map as a base to show installation-wide communications systems.
H-COMMUNICATION AND NAVAID SYSTEMS H-2 NAVAID SYSTEMS	M	1"=400' 1:4,800	Class 3	5	Shows NAVAID components such as radio transmitters, radio relay facilities, high and ultra high frequency direction finders, radio beacon shelters, GCA units, RAPCON units, PAR structures, TACAN buildings and facilities and similar information.
I-TRANSPORTATION SYSTEM I-1 COMMUNITY NETWORK - ACCESS TO BASE	M	1"=400' 1:4,800	Class 3	10	Shows all major arterial, collector streets that have direct relationship to the installation and local streets providing access to the installation.
I-TRANSPORTATION SYSTEM I-2 ON-BASE NETWORK	M	1"=400' 1:4,800	Class 3	2	Shows the transportation network including parking areas, sidewalks, and bike/hike/jogging trails on the installation.
I-TRANSPORTATION SYSTEM I-2.1 FUTURE ON-BASE NETWORK	O	1"=400' 1:4,800	Class 3	2	Shows the planned transportation network including parking areas, sidewalks, and bike/hike/jogging trails on the installation.
J-ENERGY SYSTEMS	O	1"=100' 1:1,200	Class 3	2	Shows data related to the installation's energy planning systems.
K-ARCHITECTURAL COMPATIBILITY	O	1"=400' 1:4,800	Class 3	2	Shows the installation's architectural compatibility zones and architectural districts.
L-INSTALLATION LANDSCAPE DEVELOPMENT AREA	O	1"=400' 1:4,800	Class 3	2	Shows the installation's landscape areas and planned flora.

Table 2-1
Recommended Installation Maps

NOTE: UNLESS OTHERWISE SPECIFIED THE INSTALLATION LAYOUT MAP WILL BE USED AS THE BASIS FOR THE PREPARATION OF OTHER SPECIFIED MAPS.

M-FUTURE DEVELOPMENT M-1 CURRENT	M	1"=400' 1:4,800	Class 3	5	Shows the current installation layout; (e.g., streets, parking lots, buildings, utilities etc.) to include those facilities presently under development.
M-FUTURE DEVELOPMENT M-2 FUTURE DEVELOPMENT SHORT-TERM (1-5 YEARS)	M	1"=400' 1:4,800	Class 3	5	Shows planned development on the installation including streets and parking lots, buildings, utilities and similar information.
M-FUTURE DEVELOPMENT M-2 FUTURE DEVELOPMENT SHORT-TERM (> 5 YEARS)	M	1"=400' 1:4,800	Class 3	5	Shows the facilities that will be developed beyond a five-year time frame on the installation including streets and parking lots, buildings, utilities and similar information.
O-FORCE PROTECTION O-1 SURGE CAPABILITY (BEDDOWN AND SUPPORT)	O	1"=400' 1:4,800	Class 3	5	Show areas that can be suited for temporary billeting of troops in the case of surge requirements.
O-FORCE PROTECTION O-2 PHYSICAL SECURITY	M	1"=400' 1:4,800	Class 3	5	Shows security fences, proposed and existing access points, sensor devices, location of security police units, fire stations and other similar information.
O-FORCE PROTECTION O-3 DISASTER PREPAREDNESS CRASH GRID	M	1"=400' 1:4,800	Class 3	5	Shows all buildings and building numbers with hospitals and fallout shelters, protection factors and similar information.
O-FORCE PROTECTION O-4 INSTALLATION SURVIVABILITY	O	1"=400' 1:4,800	Class 3	5	Prepared for installations to show operational contingencies.
P-PORTS AND HARBORS	O	1"=100' 1:1,200	Class 3	2	Shows berths, breakwater, channel, cable and pipeline areas, hazard areas, dry dock, navigation aides, jetties, wrecks, buoys, piers, quays, reefs, safety fairway, wharf, and other similar information.
R- TRAINING COMPLEX R-1 RANGE AREA	O	1"=400' 1:4,800	Class 3	5	Shows surface danger zones, target areas, impact areas, dudded areas, bomb circles, firing points, firing fans and lanes, range control points, and other similar information.
R- TRAINING COMPLEX R-2 TRAINING AREA	O	1"=400' 1:4,800	Class 3	5	Shows landing zones, drop zones, bivouac areas, training sites, foot traffic areas, perimeter defense, obstacle course areas, drill fields, marching areas and other similar information.

Map Accuracy Specifications

Standards have been established for the expected accuracy for maps regardless of scale. These standards have been developed so users of maps are able to use the products with confidence. Map standards are usually given in terms of an allowable error at a specific scale. The American Society for Photogrammetry and Remote Sensing (ASPRS) Map Accuracy Specifications state that the following maximum errors are permitted on maps:

Horizontal accuracy

The ASPRS specification states that 95% of all planimetric features that are well defined on photographs (assumes using photogrammetric techniques for map production) shall be plotted so that their position on the finished maps shall be accurate to within at least 1/40" of their true coordinate position, as determined by test surveys, and none of the features tested shall be misplaced by more than 1/20" from their true coordinate position.

Vertical accuracy

The ASPRS specification states that 90% of the elevations determined from solid-line contours (dashed contour lines usually indicate approximate elevations) of the topographic maps shall have an accuracy with respect to true elevation of 1/2 the contour interval or better and the remaining 10% of such elevations shall not be in error by more than one contour interval. Furthermore, 95% of the shown spot elevations must have an accuracy of at least 1/4 the contour interval, and the remaining shall not be in error by more than 1/2 the contour interval.

Note: According to the ASPRS web site (<http://www.asprs.org/>), the most recent information available on the topic of Accuracy Standards can be found on the FGDC (Federal Geographic Data Committee) web site (<http://www.fgdc.gov/>). Note that ASPRS was a contributing organization to the FGDC standards effort, and the FGDC Standard provides information necessary to correlate the earlier ASPRS standards to the current standard.

Accuracy Classes

The U.S. Army Corps of Engineers' Photogrammetric Mapping Engineer Manual refers to accuracy standards for large-scale maps that consist of three classes. Class 1 is the most accurate, while Class 2 accuracy has an allowable Root Mean Square Error (RMSE) that is twice that of the Class 1 map. Class 3 has an allowable RMSE three times that of the Class 1 map. Maps may be in one class in horizontal accuracy and another in vertical.

The RMSE is defined to be the square root of the average of the squared discrepancies. The discrepancies are the differences in the coordinates or elevation values as determined by an independent survey of higher accuracy. The RMSE is defined in terms of feet or meters at ground scale. So as map scale decreases, the RMSE increases in a linear relationship. Table 2-2 shows the maximum permissible RMSE for well-defined points as established by the standard.

There are some common understandings related to aerial mapping practices and the use of standards. For example, to obtain a 3 foot contour interval it is accepted that you fly photographing at a scale no greater than 1:1,200 (when using analytical stereo-plotting instruments to produce the map). So 1:1,200 scale maps are generally accepted to require 3 foot contours, 1:600 scale maps require 1.5 foot contours, 1:2,400 scale maps require 6 foot contours, 1:60,000 scale maps require 30 foot

contours, and 1:100,000 scale maps require 150 foot contours. Another rule of thumb is that a map produced on an analytical stereo-plotter (unlike a digital orthoregional discussed earlier in this report) should not be produced at a scale larger than six times the original data acquisition scale. So good quality 1:3,000 scale aerial photography could be used to produce a map at 1:600 (1"=50').

Table 2-2 Planimetric Feature Coordinate Accuracy Requirement (Ground X or Y in Feet) for Well-Defined Points				
Target Map Scale	Limiting RMSE in X or Y			
1"=x'	Ratio, ft/ft	Class1	Class 2	Class 3
5	1:60	0.05	0.10	0.15
10	1:120	0.10	0.20	0.30
20	1:240	0.2	0.4	0.6
30	1:360	0.3	0.6	0.9
40	1:480	0.4	0.8	1.2
50	1:600	0.5	1.0	1.5
60	1:720	0.6	1.2	1.8
100	1:1,200	1.0	2.0	3.0
200	1:2,400	2.0	4.0	6.0
400	1:4,800	4.0	8.0	12.0
500	1:6,000	5.0	10.0	15.0
800	1:9,600	8.0	16.0	24.0
1000	1:12,000	10.0	20.0	30.0
1667	1:20,000	16.7	33.3	50.0

Red = Limits of Satellite Imagery. Blue = Limits of Aerial Photography.

Green = Ground Survey Methods required.

Coordinate Systems

The U.S. Army Corps of Engineers' Photogrammetric Mapping Engineer Manual states that the most commonly encountered map projections in engineering surveying and mapping are the State Plane Coordinate System (SPCS) and the Universal Transverse Mercator (UTM). State Plane Coordinate System is defined for both the NAD 27 and NAD 83 datum. For the NAD 27 SPCS definition, the unit of length is the US Survey Foot. For the NAD 83 SPCS definition, the unit of length is variable among the states. Therefore, care must be exercised when using NAD 83 SPCS values in feet, since either the US Survey Foot or the International Foot may be used in a specific state or locality.

The UTM projection is commonly used in the military. UTM uses a scale factor of 1/2500 (0.9996

= 1/2500) to reduce the number of UTM zones for the entire world to 60. In 1930, the U.S. National Geodetic Survey developed the State Plane Coordinate System (SPCS) to increase the accuracy of the coordinate system for civil use. The SPCS uses a scale factor of 1/10,000. Measured distances on the ground more closely correspond to grid distances with a Grid System judiciously designed for civil use (Mugnier, 1998). Therefore, the SPCS is the recommended coordinate system for installation maps within the Continental United States (CONUS).

Aerial Photography Parameters

Flight height for aerial photography acquisition is usually given as an average above ground elevation and planned in accordance with the desired accuracy specifications for the intended mapping. For most installation mapping activities, aerial cameras with a 6" focal length are employed. Table 2-3, Aerial Photography Acquisition Parameters, displays parameters needed to obtain mapping specifications indicated in this guide. Mapping scales larger than 1"=40' should be obtained using conventional survey methods. Mapping scales smaller than 1"=500' should be obtained using the latest satellite technology. It should be noted that mapping scales between 1"=100 and 1"=500' can also be obtained using satellite imagery. These parameters are subject to change as new satellite technology is deployed.

Aerial film negatives that have a departure from the specified scale of more than 5% due to tilt or flight height variations are normally unacceptable. Flight height variation of the actual height exceeding the specifications by, for example, 2% low or 5% high may be grounds for rejection of the aerial photography. Cloud cover greater than 5% in a single image is unacceptable. To support stereocompilation, end-lap for the aerial photography is usually specified at 60% with a permissible variation of no more than +/- 5%. Lateral side-lap is normally 30% with a permissible variation of no more than +/- 10%. Absolute crab (displacement of the principal point in a photograph) exceeding 5-10° between two or more photos is usually cause for rejection. Average crab for a flight line should not exceed 3-5 degrees.

Tilt specifications are given for frames (i.e., no more than 4°). Also specified is the average tilt for a series of consecutive photos (i.e., no more than 2° for any specified count of consecutive photos), as an average for the entire project (i.e., no more than 1°), and relative tilt between consecutive photographs (i.e., no more than 6°). The particular requirements for the aerial mission may modify one or more of these parameters, but these are useful guidelines for specifying the aerial photography requirement.

Table 2-3: Aerial Photography Acquisition Parameters

Photo Scale Range	Altitude (meters)	Altitude (feet)	Map Scale Range	Map Scale 1"=x'	Contour Interval (meters)	Contour Interval (feet)	Typical Use
1:4,800	732	2,400	1:480	1"=40'	.41	1	Site map
1:5,000	760	2,493	1:600	1"=50'	.41	1	Small Area Development Map Utility Maps
1:9,600	1,463	4,800	1:1200	1"=100'	.83	2	Area Development Map Special Area Maps - Airfields, Ports, Harbors etc.

1:24,000	3,658	12,000	1:2400	1"=200'	1.6	5	Cantonment Area Map Land Use Map
1:48,000	7,315	24,000	1:4800	1"=400'	3.7	20	Environmental Concern Area Transportation Access Map
1:50,000	7,620	25,000	1:6000	1"=500'	3.7	20	Installation Layout Map

Common Installation Geospatial Data

Collection and analysis of geospatial data are vital to the management of the installation. This effort must focus on ensuring that data is available to meet the requirements of installation commanders and their subordinate units. Most of the geospatial data maintained by an installation will eventually be represented in a graphic format (e.g., plan graphics, digital image, or a map). In general, an installation maintains maps that depict the following, or similar, geospatial information:

A-Natural and Cultural Resources

A-1 Areas of Critical Concern

- Historic Preservation and Archeology
- Threatened and Endangered Species
- Wetlands & Floodplains
- State Coastal Zones
- Lakes, Rivers, Streams, and Water Bodies
- Soil Borings & Soil Types

A-2 Management Areas

- Geology, including Surface Features
- Topography & Physiology
- Hydrology
- Vegetation Types
- Forest (Commercial Timber)
- Agriculture Grazing/Crops
- Fish and Wildlife
- Prime & Unique Soils

- Grounds Categories

- Climate & Weather

- Bird Aircraft Strike Hazard (BASH)

- Outdoor Recreation

- Pest Management

B-Environmental Quality

B-1 Environmental Regulatory

- Hazardous Waste Generation Points
- Permitted Hazardous Facilities
- Solid Waste Generation Points
- Solid Waste Disposal Locations
- Fuel Storage Tanks
- Installation Restoration Program (IRP)

B-2 Environmental Emissions

- Air Emission
- Waste Water NPDES Discharge
- Storm Water NPDES Discharge
- Drinking Water Supply Sources

- Electromagnetic and Radiation Sources

- Radon Sources

C-Layout and Vicinity Maps

C-1 Installation Layout

C-2 Off-base Sites

C-3 Regional Location

C-4 Vicinity Location

C-5 Aerial Photographs

C-6 Installation Boundary

D-Land Use

D-1 Existing Land Use

D-1.1 Future Land Use

D-2 Off-base Sites Land Use

D-2.1 Off-base Sites Future Land Use

D-3 Real Estate

D-4 Explosive Safety Quantity-Distance (QD) Arc

D-5 Hazard Analysis Constraints

D-6 Composite Installation Constraints and Opportunities

D-7 Area Development

E-Airfield Operations

E-1 On base Obstruction to Airfield and Airspace Criteria

E-2 Approach and Departure - Zone Obstructions to 10,000 Ft

E-3 Approach and Departure Zone Obstructions Beyond 10,000 Ft

E-4 Airspace Obstruction - Vicinity

E-5 Terminal Enroute Procedures (TERPS) Automation Plan

E-6 Airfield and Airspace Clearances

- Waivers

- Clear Zones

- Primary Surfaces

- Transitional Surface (7:1)

- Approach and Departure Surface (50:1)

- Approach and Taxiway Clearances

E-7 Airfield Pavement Plan

E-8 Airfield Pavement Details

E-9 Aircraft Parking Plan

E-9.1 Proposed Aircraft Parking Plan

E-10 Airfield Lighting Systems

F- Reserved

F-1 Reserved

F-2 Reserved

G-Utilities System Plan

G-1 Water Supply System

G-2 Sanitary Sewerage System

G-3 Storm Drainage System

G-4 Electrical Distribution System (Street & Airfield)

G-5 Central Heating and Cooling System

G-6 Natural Gas Distribution System

<i>G-7 Liquid Fuel System</i>	<i>O-1 Surge Capability (Beddown and Support of Deployed Forces)</i>
<i>G-8 Cathodic Protection System</i>	<i>O-2 Physical Security</i>
<i>G-9 Cathodic Protection System Details</i>	<i>O-3 Disaster Preparedness Crash Grid Map</i>
<i>G-10 Industrial Waste and Drain System</i>	<i>O-4 Air Base Survivability and Theater-Specific Requirements</i>
<i>G-11 Composite Utility System Constraints</i>	P - Ports and Harbors
<i>G-11.1 Central Aircraft Support System</i>	R - Range and Training Areas
<i>G-12 Other Utility Systems</i>	
H-Communication and NAVAID Systems	
<i>H-1 Installation Communication (Base and civilian communications units)</i>	
<i>H-2 NAVAIDs and Weather Facilities</i>	
I-Transportation System	
<i>I-1 Community Network Access to Base</i>	
<i>I-2 On-base Network</i>	
<i>I-2.1 Future Transportation Plan</i>	
J-Energy Plan	
K-Architectural Compatibility	
L-Landscape Development Area	
M-Future Development	
<i>M-1 Current Status</i>	
<i>M-2 Short-Range Development</i>	
<i>M-3 Long-Range Development</i>	
N-Reserved	
<i>N-1 Reserved</i>	
<i>N-2 Reserved</i>	
O- Force Protection	

A-E quality management, responsibility, liability, and performance

When work is performed by contract, A-E's should be required to submit a Quality Control Plan (QCP) at the beginning of all major surveying and mapping projects. USACE ER 1110-1-12, "Quality Management" can be used as a guide in the development of the QCP. A-E contractors are responsible for the professional quality, technical accuracy, and coordination of all services required under their contracts (FAR 36.608f and USACE ER 715-1-10, "A-E Responsibility Management Program (AERMP)." Interim and post-contract A-E performance appraisals (DD Form 2631) should be prepared in accordance with USACE ER 715-1-17, "A-E Performance-Evaluation."

Federal standards for coordinating geospatial data acquisition and access

Executive Order (EO) 12906, "Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure," prescribes Federal policies and establishes mechanisms for acquiring, processing, storing, distributing, and improving utilization of geospatial data. This directive applies to most geospatial data described herein. The contract documents should contain provisions requiring that the contractor prepare the metadata files and deliver them to the Government along with the other contract deliverables. The USACE has developed guidance on implementing EO 12906 (ER 1110-1-8156) and the other DoD agencies are investigating the development of similar guidance.

Metrication

Surveying and mapping performed for design and construction should be recorded and plotted in the units prescribed for the project by the requesting organization or end-user. Policy relating to the application of the metric system in military construction is addressed in USACE ER 1110-345-100, "Design Policy for Military Construction." During transition to the metric system, inch-pound (IP) units or soft conversions may be required for some geospatial data covered under this regulation. Applicable hard and soft metric conversions are indicated throughout this chapter. Reference ACSM Metric Practice Guide for Surveying and Mapping (1978).

Topographic Surveys and Construction Site Plans

Topographic surveys and construction site plan surveys are performed for the master planning, design, and construction of installations, buildings, housing complexes, roadways, airport facilities, flood-control structures, navigation locks, etc. Construction plans are performed at relatively large scales (typically ranging between 1 in. = 20 ft to 1 in. = 400 ft (1:240 to 1:4,800) using electronic total

stations, plane tables, or low-altitude photogrammetric mapping methods (see Appendix G for recommended map scales). Guidance for performing topographic surveys is contained in a variety of commercial and Government publications (e.g., Field Technical Publication 5-82014-FM-TG, “Soldier's Manual and Training Guide”; FM 5-232, “Topographic Surveying”; or USACE EM 1110-1-1000, “Photogrammetric Mapping”). USACE EM 1110-1-1005, “Topographic Surveying,” is the most current guidance publication, and details procedures for field electronic data collection of features using electronic total stations. Other recognized industry standards, manuals, or surveying textbooks may also be used for guidance in performing plane table surveys, total station surveys, and radial topographic mapping methods using kinematic DGPS. For all types of topographic surveys or site plan surveys, the mapping specifications must clearly indicate the level of surface and underground feature detail to be mapped (see guidance specifications in Appendix B (Planimetric and Topographic Feature Depiction Specifications) of USACE EM 1110-1-1000, “Photogrammetric Mapping”).

Reconnaissance topographic surveys

These surveys are performed at relatively small scales--from 1 in. = 400 ft (1:4,800) to 1 in. = 1,000 ft (1:12,000). They provide a basis for general studies, site suitability decisions, or preliminary site layouts. General locations of existing roads and facilities are depicted, and only the limited feature and rough elevation detail are shown. Five- to ten-foot contour intervals are usually adequate. Enlarged USGS 1:24,000 maps may be substituted in many cases.

General/preliminary site plans

Scales are from 1 in. = 200 ft to 1 in. = 400 ft (1:2,400-1:4,800). The plan depicts the general layout arrangement of areas where construction will take place, proposed transportation systems, training areas, and existing facilities.

Detailed topographic surveys for construction site plan drawings

Scales are from 1 in. = 20 ft to 1 in. = 200 ft and 1- or 2-ft contour intervals. Detailed ground topographic surveys are performed to prepare a base map for detailed site plans (general site layout plan, utility plan, grading plan, paving plan, airfield plan, demolition plan, etc.). Scope of mapping should be confined to the existing or proposed building area. The map should be used as the base for subsequent as-built drawings of facilities and utility layout maps (i.e., AM/FM databases).

Hydrographic Surveying Standards and Specifications

Hydrographic surveying accuracy standards, specifications, and guidance are contained in USACE EM 1110-2-1003, "Hydrographic Surveying." This EM should be referenced in construction dredging contracts involving in-place measurement and payment. Standards in this manual apply to river and harbor navigation project surveys, such as dredge measurement and payment surveys, channel condition surveys of inland and coastal Federal navigation projects, beach renourishment surveys, and surveys of other types of marine structures. EM 1110-2-1003 specifies accuracy standards for three distinct classes of surveys: Contract Payment, Project Condition, and Reconnaissance Surveys (see Table 2-4). There are no recognized industry standards for performing detailed, large-scale hydrographic surveys of navigation projects; thus, use of EM 1110-2-1003 is essential. Requirements for compliance with EM 1110-2-1003 are contained in USACE ER 1130-2-520, "Navigation and Dredging Operations and Maintenance Policies." This manual defines accuracy standards and field procedural specifications for dredge measurement and payment surveys.

Table 2-4 Accuracy Standards for Hydrographic Surveys			
Measurement	USACE Survey Classification		
	1	2	3
	Contract Payment	Project Condition	Reconnaissance Survey
Horizontal position ¹	3 m (10 ft)	6 m (20 ft)	100 m (328 ft)
Elevation ² or depth	±0.15 m ±(0.5 ft)	±0.30 m ±(1.0 ft)	±0.46 m ±(1.5 ft)
¹ 2DRMS accuracy-approximately 95% probability. ² One-sigma.			

Navigation project charts and channel condition reports

Procedures for disseminating USACE navigation information to the marine industry, the public, and other Government agencies are prescribed in USACE ER 1130-2-520, "Navigation and Dredging Operations and Maintenance Policies."

Bathymetric surveys

Standards for surveys of coastal waters outside Federal navigation projects, or deep-water bathymetric charting surveys, should conform to applicable Defense Mapping Agency (DMA), National Ocean Survey (NOS), or Naval Oceanographic Office (NAVOCEANO) accuracy and chart symbolization criteria.

Cadastral/Real Estate Survey Standards

Guidance

Many state codes, rules, statutes, or general professional practices prescribe minimum technical standards for surveying and mapping. In-house surveyors or contractors should follow applicable state minimum technical standards for real property surveys involving the determination of the perimeters of a parcel or tract of land by establishing or reestablishing corners, monuments, and boundary lines for the purpose of describing, locating fixed improvements, or platting or dividing parcels. Although some state standards relate primarily to accuracy of land and boundary surveys, other types of survey work may also be covered in some areas. See also USACE ER 405-1-12, “Real Estate Handbook” and the “Manual of Instructions for the Survey of the Public lands of the United States” (U.S. Bureau of Land Management 1947) for cadastral surveys or surveys of private lands abutting or adjoining Government lands.

ALTA/ACSM standards

Table 2-5 depicts the closure standards prescribed by ALTA/ACSM (Minimum Standard Detail Requirements for ALTA/ACSM Land Title Surveys, 1992). This standard was developed to provide a realistic national standard for land title surveys and may be used as a guide in specifying closure requirements for DoD cadastral type surveys. However, it should be noted that the ALTA/ACSM standard itself not only prescribes closure accuracy for land use classifications, but also addresses specific needs peculiar to land title insurance matters. The standards contain requirements for detailed information and certification pertaining to land title insurance, including information discoverable from the survey and inspection that may not be evidenced by the public records.

Table 2-5 ALTA-ACSM Minimum Closure Standards for Cadastral Surveys
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Survey Classification ALTA/ACSM Class	Closure Standard	
	Distance (Ratio)	Angle ¹ (secs)
Urban	1:15,000	10 \sqrt{N}
Suburban	1:10,000	15 \sqrt{N}
Rural	1:7,500	20 \sqrt{N}
Mountain/Marshland	1:5,000	30 \sqrt{N}
¹ N = number of angle stations. $\sqrt{}$ = square root.		

The standard also contains a table of optional survey responsibilities and specifications which the title insurer may require. Surveys not involving title insurance should follow state minimum standards, not ALTA/ACSM standards. On land acquisition surveys which may require title insurance, the decision to perform an ALTA/ACSM standard survey, including all optional survey responsibilities and specifications, should come from the title insurer. The four ALTA/ACSM classes are defined as (1) Urban Surveys - Surveys of land lying within a city or town, such as commercial properties, condominiums, townhouses, apartments, multi-unit dwellings, etc., (2) Suburban Surveys - Surveys of land outside urban areas, such as single family residences or residential subdivisions, (3) Rural Surveys - Surveys of farms and other undeveloped land outside suburban areas which may have potential for future development, and (4) Mountain and Marshland Surveys - Surveys of land lying in remote areas with difficult terrain and having limited potential for development. Meeting ALTA/ACSM Urban Class standards is often difficult for small tracts or parcels less than 1 acre (4,046 square meters) in size.

Photogrammetric Mapping Techniques and Standards

In specifying photogrammetric mapping services, it is essential that feature accuracy tolerances (horizontal and vertical) be clearly identified relative to the project target mapping scale. Procedures for developing photogrammetric mapping specifications are contained in USACE EM 1110-1-1000, "Photogrammetric Mapping." EM 1110-1-1000 contains guidance on specifying flight altitudes, determining target scales, and photogrammetric mapping cost-estimating techniques. A full contract Guide Specification is also contained in an appendix to the manual. More comprehensive technical guidance may be obtained from the "Manual of Photogrammetry" (ASPRS 1980). Neither of these references currently reflect the latest uses and potential efficiencies of GPS-controlled photogrammetry.

GPS Surveying and Mapping Techniques

GPS satellite positioning technology allows development of map features to varying levels of accuracy, depending on the type of equipment and procedures employed. Given this rapidly developing technology, GPS surveying specifications rapidly become obsolete; therefore, it is best to follow the GPS equipment manufacturer's recommended procedures. General guidance on performing GPS control surveys is in USACE EM 1110-1-1003, "NAVSTAR Global Positioning System Surveying." The advent of local area differential GPS (LADGPS) and wide area augmented GPS (WAAS) allows direct, near real-time positioning of static AM/FM type features and dynamic platforms (survey vessels, aircraft, etc.).

Site plan drawings, photogrammetric control, and related GIS features can be directly constructed from GPS observations, at accuracies ranging from 1 cm to 100 m 2DRMS. Accuracy classifications of maps and related GIS data developed by GPS methods can be estimated based on the GPS positioning technique employed. Permanent LADGPS reference stations (Continuously Operating Reference Stations (CORS)) can provide decimeter-level, and even centimeter-level, point positioning accuracy over wide ranges; thus providing direct map/feature point positioning without the need for preliminary control surveys.

When map features are to be located by GPS point positioning techniques, A-E contract specifications need only indicate the required feature accuracy--the contractor should recommend the appropriate GPS survey technique for achieving this result based on his/her equipment capabilities.

Digital Orthophotography, Image File, and Map Production

Digital orthophotography is used to a great extent to replace or supplement the vector-based planimetric maps used with GIS's (and GDS's). Digital orthophotographs (or digital orthophotos) consist of a photogrammetric base. Digital orthophotographs are created by scanning a diapositive transparency (a film positive prepared from the original negative) produced from an aerial photograph using a precision image scanner, and rectifying the scanned data to an orthographic projection on a pixel-by-pixel basis.

The term digital orthophotograph is often confused with other types of photogrammetric mapping products, as summarized below:

Aerial Photograph - No ground control (in the form of surveyed points or points from existing maps or points) is used and distortion due to tip, tilt, and

ground surface relief may be present.

Scaled Photograph - Two ground control points are used, distortion due to ground surface relief may be present, and the photograph may be accurate only between the two points.

Rectified Photograph - Three or more ground control points are used, distortion due to ground surface relief may be present, and photograph is adjusted to best fit or warp to control.

Digital Orthophotograph - Photograph is adjusted to several thousand control points produced from a digital terrain model (DTM), is adjusted on a pixel-by-pixel basis with a consistent scale and accuracy, and all distortions are removed.

Digital orthophotographs can have two different types of accuracy: relative and absolute. The output or plot scale of the digital orthophotograph determines its relative accuracy. The pixel size in the image must be appropriate for showing the necessary ground details at the desired plot scale. Table 2-6 provides the recommended approximate pixel sizes for digital orthophotographs at selected final map plot scales.

Table 2-6 Recommended Approximate Pixel Sizes for Selected Final Digital Orthophotograph Map Plot Scales	
Final Plot Scale	Approximate Pixel Size Required to Meet National Map Accuracy Standards
1 in. = 20 ft	1 in.
1 in. = 40 ft	2 in.
1 in. = 100 ft	6 in.
1 in. = 200 ft	1 ft
1 in. = 400 ft	2 ft
1 in. = 500 ft	2.5 ft
1 in. = 1,000 ft	5 ft

The absolute accuracy of a digital orthophotograph is related to the following components:

Magnification - In order to maintain image quality, black-and-white aerial photography should not be magnified or enlarged more than a factor of 8.5 times the original size. For example, if the final scale of an orthophotograph is 1 in. = 50 ft (1:600), a photograph scale of less than 1 in. = 425 ft is recommended. The costs increase rapidly when aerial photography is enlarged less than a factor of 5 times. The optimum enlargement range for

black-and-white aerial photography lies somewhere between 5 to 8.5 times the original size. Color aerial photography should not be magnified or enlarged more than a factor of 6 times the original size.

Control Points - The control points chosen to orient the orthodiapositives over a Digital Elevation Model (DEM)

Scanner's Geometric Accuracy

DEM Quality and Camera Focal Length

3 Data Deliverables

Introduction

A general checklist and discussion of the basic items to consider when specifying A-E GDS deliverables criteria are included in this chapter. Additional information concerning each item can be obtained from the current release of the SDS and A/E/C CADD Standard. The items discussed are considered generic to all DoD target organizations. Project- or organization-specific requirements may necessitate additional requirements which are not addressed in this document.

Ownership

The Government's rights to ownership of the digital data and other deliverables developed by the A-E under the contract must be clearly defined in the technical contract provisions. The Government has a legal right to demand unrestricted ownership to all data, designs, and materials for which the Government has paid 100 percent of the development cost. If the contractor has to develop data, designs, or materials above and beyond what the Government specifies and pays for 100 percent, then the contractor owns the rights to that percentage.

A statement similar to the following should be included in each A-E contract. The appropriate organization's contracting or legal counsel office should review the DFAR's to ensure that the current clauses are referenced.

The Government, for itself and such others as it deems appropriate, will have unlimited rights under this contract to all information and materials developed under this contract and furnished to the Government and documentation thereof, reports and listings, and all other items pertaining to the work and services pursuant to this agreement including any copyright. Unlimited rights under this contract are rights to use, duplicate, or disclose data, and information, in whole or in part in any manner and for any purpose whatsoever without compensation to or approval from the Contractor. The Government will at all reasonable times have the right to inspect the work and will have access to and the right to make copies of the above-mentioned items. All digital files and data, and other products generated under this contract, shall become the property of the

Government. By reference, the following DFAR clauses are included in this contract as a part of the requirements herein:

- a. DFAR 252.227-7013, "Rights in Technical Data - Noncommercial Items."*
- b. DFAR 252.227-7017, "Identification and Assertion of Use, Release, or Disclosure Restrictions."*
- c. DFAR 252.227-7020, "Rights in Special Works."*
- d. DFAR 252.227-7028, "Technical Data or Computer Software Previously Delivered to the Government."*
- e. DFAR 252.227-7037, "Validation of Restrictive Markings on Technical Data."*
- f. DFAR 252.227-7025, "Limitations on the Use or Disclosure of Government-Furnished Information Marked with Restrictive Legends."*
- g. DFAR 252.227-7014, "Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation."*

Copyright: Any software and computer data/information developed as a component of this contract shall have the following statement attached to documentation:

"This computer program is a work effort for the United States Government and is not protected by copyright (17 U.S. Code 105). Any person who fraudulently places a copyright notice on, or does any other act contrary to the provisions of 17 U.S. Code 506(c) shall be subject to the penalties provided therein. This notice shall not be altered or removed from this software or digital media, and is to be on all reproductions."

Target GDS Considerations

Target GDS

The target GDS should be specified in the technical contract documents. The A-E firm should not be required to use the same hardware as the target organization. (Note: Although the A-E can not be required to use a specific target system, current legal rulings allow the requirement of deliverables to be in a specific final format.) However, the A-E should use the same type and version of operating system software as the target organization.

The type and version of the GDS software used by the target organization must be specified in both the *FedBizOpps* announcement and the technical contract documents. In addition, the type(s) and version(s) of the application software package(s), and DBMS software package(s) used by the target organization must be specified in the technical contract documents. Different types of software packages used by A-E's may not be compatible with those used by the target organization. Therefore, it is very important to ensure that A-E's either prepare their geospatial and related data, and maps, using the same GDS, DBMS, and appurtenant software package(s) as those used by the target organization, or provide electronic deliverables which can be read and used directly by the target organization's GDS. The term "compatible" means that data can be accessed directly by the target GDS without translation, preprocessing, or postprocessing of the data files.

The target GDS includes the following basic components which are currently installed, or are to be installed, at the organization which will be receiving and using the geospatial data:

- The platform (computer hardware and operating system).
- The GDS/CADD software.
- The RDBMS software, database schema, and data.
- Digital media containing the organization's graphic and attribute geospatial data.

The digital media are formatted to conform to the organization's GDS standards, and installed to function as an integral part of the GDS. The GDS database is "populated" with attribute data.

It is recommended, but not required, that consulting firms develop their GDS maps and geospatial-related data using the specified target GDS. However, it is important that consulting firms deliver the geospatial data in a digital format compatible with the receiving organization's target GDS. The advantages of

using GDS technology will not be realized, and the expenditure of additional funds and labor will be necessary, if the geospatial data are delivered in a format which is not compatible with the organization's target GDS.

If the Government's target GDS is not yet operational (i.e., the Government has the hardware and software components, but not the digital media containing the graphic and attribute geospatial data), the consulting firm should be required to develop, deliver, install, and test the digital media containing the geospatial data at the Government organization using the Government's target GDS.

Digital Media

The type of digital media and number of copies to be provided by consulting firms with the GDS deliverables should be specified. Electronic digital media may consist of any of the following:

- a.* high-density back-up disks (e.g., ZIP or JAZ).
- b.* 3-1/2-in. high-density floppy disks (1.44 Mb formatted).
- c.* Compact disc read-only memory (CD-ROM) with International Standards Organization (ISO)-9660 format.
- d.* 10 gb tape (DAT).
- e.* Writable DVD.

It is recommended that files or sets of files that have to be stored on more than four floppy disks be furnished on CD-ROM, with International Standards Organization (ISO)-9660 format due to their longer shelf life. All digital media stored on magnetic tape should be transferred to new tapes or CD-ROM within 1 year. CD-ROM is considered to have a storage life expectancy of 10 to 20 years.

The external label for digital media should contain, as a minimum, the following information.

- a.* The Contract Number (and Delivery Order Number if applicable) and date.
- b.* The format and version of operating system software.
- c.* The name and version of utility software used for preparing (e.g., compression/decompression) (if applicable) and copying files to the media.

- d.* The sequence number of the digital media.
- e.* A list of the filenames on the digital media (as space on the label permits).

In addition, a transmittal sheet containing, at a minimum, the following information should accompany the media. A digital ASCII copy should also be included on the transmitted digital media in a “readme” file.

- a.* Information included on the external label of each CD along with the total number being delivered, and a list of the names and descriptions of the files on each one.
- b.* Instructions for transferring the files from the media if applicable.
- c.* Certification that all delivery media are free of known computer viruses. A statement including the name(s) and release date(s) of the virus-scanning software used to analyze the delivery media, the date the virus scan was performed, and the operator's name should also be included with the certification. The release or revision date of the virus-scanning software should be the most current version known to detect the latest viruses at the time of the delivery of the media.
- d.* A statement indicating that the consulting firm will retain a copy of all delivered digital media (with all files included) for at least 1 year and, during this period of time, will provide a reasonable number of additional copies of each to the Government, if requested, at no additional cost.

Digital Deliverables Checklist

Consulting firms should deliver all data files in a format that is directly readable and compatible with the target organization's GDS. The term “compatible” means that data can be accessed directly by the target GDS software and platform without translation or preprocessing of data files. Before a data file is placed on the delivery digital media, the following checklist should be performed:

- a.* Remove all extraneous graphics outside the border area and set the active parameters to a standard setting or to those in the Government-furnished seed file.
- b.* Make sure all reference (or XREF) files are attached without device or directory specifications.
- c.* Deliver files to the Government uncompressed. However, if that is not possible, the files should be compressed and reduced using either (1) a

self-extracting archive utility or (2) the appropriate compression/decompression utility software specified by the Government. If the consulting firm does not use the same compression/decompression utility software the Government uses, then the consulting firm must purchase a copy of the software for the Government and provide it with the GDS deliverable media. The use of CD-ROM as the delivery media will all but eliminate the need for compression/decompression utility software.

- d. Include all files, both graphic and non graphic, required for the project that are not included in the GDS/CADD software (i.e., color tables, pen tables, font libraries, symbol libraries, user command files, plot configuration files, AML plot routines, etc.).
- e. Make sure that all support files such as those listed above are in the same directory and that references to those files do not include device or directory specifications.
- f. Document any fonts, tables, symbols, cells/blocks, line styles/types, details, reference drawings, etc., developed by the consulting firm or not provided with the GFM. Consulting firms must obtain Government approval before using anything other than the Government's standards.

File names

A standard system for establishing file names should be established by each target organization. Recommended file-naming conventions are discussed in the SDS and A/E/C CADD Standard. It is also recommended that an electronic DBMS for organizing and maintaining records of file names and pertinent project information be established and maintained for each target organization.

A-E's should use the same standard file-naming convention used by the target organization for which the work will be accomplished. The appropriate standard should be referenced in the technical contract provisions, and should be furnished to the A-E as a part of the Government-furnished materials (GFM).

Basic Graphic Standards

Datums and coordinate systems

Datums and coordinate systems should conform to the requirements of the SDS and the A/E/C CADD Standard.

Map plot size

A map plot size conforming to the target organization requirements should be specified. The three most predominant (inch-pound unit) sizes (according to the American National Standards Institute (ANSI) Y14.1) and currently used by the DoD are (a.) a D-size drawing, 22 in. vertical by 34 in. horizontal (as measured between the cut lines), (b.) an E-size drawing, 34 in. vertical by 44 in. horizontal (as measured between the cut lines), and (c.) an F-size drawing, 28 in. vertical by 40 in. horizontal (as measured between the cut lines) (ANSI 1995). According to ANSI Y14.1, the International (SI unit) counterpart for the D-size drawing is the A1 drawing (841 mm horizontal by 594 mm vertical) and the counterpart for the E-size sheet is an A0. An International counterpart for the F-size drawing is not provided in ANSI Y14.1.

Units

The resolution and scaling of the graphics file affect the accuracy and limits of the map (design plane). The units will determine the accuracy and expanse of the graphics file.

Units should conform to the SDS or the A/E/C CADD Standard. The requirement to use inch-pound or SI units should be specified in the contract technical provisions. DoD policy requires agencies to begin using SI units as the standard unit of measure. For updates on DoD policy for metrification, refer to the Construction Metrification Council of the National Institute of Building Sciences at <http://www.nibs.org>.

Symbol libraries

All symbol (i.e., cells, blocks) libraries should be prepared in accordance with the SDS or the A/E/C CADD Standard. Symbol libraries typically contain symbols which are used on a repetitive basis in preparing GDS files, and are typically not altered with each application. The standard symbol libraries used by the target organization, or provided with the SDS or A/E/C CADD Standard, should be furnished to the A-E as a part of the Government-furnished materials (GFM). All symbol libraries not provided as GFM and used by the A-E must be provided to the Government as a part of the electronic digital deliverables.

Origin

The location of the origin for each file should conform to the requirements of the SDS, the A/E/C CADD Standard, or specific target organization requirements. The same origin or reference points shall be used on all files for a project,

and the A-E must coordinate origins across files.

Scales

All GDS graphic files should be developed in actual (real world) size. Maps should be developed and plotted at the scale required by the target organization.

Text

Text size, format, and placement should conform to the SDS or A/E/C CADD Standard. For applications not addressed in the SDS or A/E/C CADD Standard, use either: (1) each service's current mapping standards, or (2) the fonts provided with the GDS software packages. This includes nodal/attribute text and dimension text (while part of those entities).

Font libraries

Font libraries should conform to the SDS or A/E/C CADD Standard. For applications not addressed in the SDS or A/E/C CADD Standard, use either: (1) each service's current font library, or (2) the fonts provided with the GDS software packages. Any additional custom fonts used by the A-E must be provided to the Government along with the electronic digital deliverables.

Line weights/thicknesses

Line weight/thickness should conform to the SDS or the A/E/C CADD Standard.

Line styles/types

Digital line styles/types in AutoCAD, MicroStation, and ArcInfo digital formats are available with the SDS and the A/E/C CADD Standard. The most commonly used line styles/ types - continuous, dotted, dashed, dashed spaced, dashed dotted, dashed double dotted, dashed triple dotted, chain, chained doubled dashed – are a standard part of CADD packages. (Note: Of these, only continuous, dashed chain, and chained double dashed are ISO-compliant.) Any custom line styles/types developed by the A-E must be provided to the Government with the electronic digital deliverables.

Levels/layers

Level/layer assignments should conform to those established in the SDS or the A/E/C CADD Standard. The characteristics of AutoCAD and MicroStation mandate that organizations address the limitations of MicroStation. Pre-V8 versions of MicroStation accept up to 63 layers per map file. Additional layers may be attained through the use of reference files or in using the latest version (Version 8) of MicroStation that eliminates the 63 level restriction. AutoCAD accepts an unlimited number of layers.

Colors

Color assignments should conform to those established in the SDS or the A/E/C CADD Standard. The same colors should be used for both display and plotting.

Reference Files

Reference files are graphics files used as overlays to the current graphic file. This capability is very productive because when the reference file is changed, the system automatically updates all files with that reference file attached without the need to update each file. Reference files should be prepared in accordance with the same standard and format as graphics files. Examples of reference files might include standard border sheets, standard titles, floor plans, topographic maps, and contour maps. Reference files are not used with ArcInfo, and are called XREF files in AutoCAD.

Standard reference files containing border sheets, title blocks, etc., should be furnished to A-E's as a part of the GFM.

Titles or border sheets

Titles or border sheets should conform to the standard sizes and formats addressed in the A/E/C CADD Standard. Title blocks should contain the target organization's standard information and format.

Vector graphics

Vector elements are graphical objects which have a precise direction, length, and shape. The vector graphical objects can be points, lines, polygons, arcs, rectangles, circles, splines, text, ellipses, elliptical arcs, arc wedges, elliptical arc wedges, and symbols.

Grouped vector objects are either in the form of graphic groups or complex elements such as cells or blocks. Vector graphics are particularly well-suited for processes where map development and modification are heavy and true two- and

three-dimensional accuracy is required. Vector graphic images can exist in two- or three-dimensional design environments and are created using GDS software packages. In addition, the ability to deal with geometric elements as unique entities provides a powerful linkage for images to be grouped with nongraphical data attributes. Output from GDS software packages creates a binary data file that has limited portability across various platforms and vendor packages, unless it is converted into a “neutral” data format.

In addition to the vector entities, digital maps may also contain symbols and details (cells/blocks), reference maps, and reference database files. All of these must be a part of the deliverables, or transfer from one digital format to another.

Two-dimensional vector entities are represented by x- and y-coordinate points, taking the form of a single point, string of points (e.g., lines, arcs, and splines), and closed lines (e.g., polygons, rectangles, circles, and ellipses).

Three-dimensional vector entities are represented by x-, y-, and z-coordinate points.

Raster graphics

Raster graphics, or bit-mapped graphics, are digital images stored as arrays of pixels for display and modification. In raster data there are no lines, circles, or polygons, only pixels that are grouped to give the appearance of these elements. In order to possess properties that can be used by a GDS to perform analyses, raster graphics have to be converted to vector graphics.

In a monochrome (black and white) graphic system, each pixel corresponds to one binary digit (bit) on the display screen. A bit is the smallest unit of information that a computer can handle. Color graphic systems require more bits per pixel to create colors. The need for more memory and memory management increases as both color and screen resolution increase.

Raster graphics are commonly created in one of two ways:

- a.* Use of “paint” type computer graphics programs (e.g., desktop publishing, image editing, and paint) to draw and edit images.
- b.* Quick capture by scanning the image of existing hard-copy maps and converting them to a digital format (bit-mapped). Once captured digitally, the maps can be archived, distributed, or converted to a vector format. The scanning can be accomplished by either electronic scanning equipment or digital cameras.

Some of the more common raster (bit-mapped) file formats in use include:

- a.* Microsoft Windows Paintbrush (PCX).

- b. Tag Image File Format (TIFF).
- c. Graphics Interchange Format (GIF).
- d. Bit-Mapped Picture (BMP).

The type(s) and versions(s) of raster graphics software packages used by the target organization should be addressed in the contract technical provisions.

“Neutral” file exchange formats

CADD graphic files converted to “neutral” file exchange formats such as Drawing Exchange Format (DXF) and Initial Graphics Exchange Specification (IGES) can be converted by most CADD and GDS software to their native file formats. However, caution should be exercised because the “neutral” file exchange formats may not transfer all the graphic elements (e.g., arcs, splines) stored in the native CADD file format. Basic CADD software packages and add-on or third-party CADD software application packages are typically employed to develop CADD drawings. Few of the “neutral” file exchange formats currently available have reliable mechanisms to transfer the wide variety of electronic linkages between graphic elements and nongraphic attributes used in basic and advanced CADD software packages.

DXF, although widely supported and well known, was developed by Autodesk to support the graphic elements generated by AutoCAD. Because DXF maps AutoCAD graphic entities, it is only “neutral” to the extent that AutoCAD entities are common to most other CADD software packages.

The set of graphic elements available in IGES is sufficient to represent the graphics from almost any CADD software package. IGES is a public standard.

Both DXF and IGES file exchange formats will exchange two-dimensional drawings, two- and three-dimensional wireframe models, and simple three-dimensional surfaced solids. “Neutral” file exchange formats, such as DXF and IGES, were established for the exchange of CADD-generated graphic entities. They can tell you what in the world it is fairly well, but do not tell you where in the world it is.

Many problems associated with DXF and IGES file exchange can be prevented by: avoiding the use of certain graphic elements, converting complex graphic elements to simpler forms, using simple and standard text fonts, and careful control of layering and symbology.

When translating to and from “neutral” file exchange formats, each CADD package tries to transfer the appearance of the “neutral” file exchange format's graphic elements into the types of graphic elements it supports. This works well for simple graphic elements (e.g., lines, circles, and rectangles), but does not work well for complex graphic elements. The “neutral” file exchange format's graphic elements which are not supported by the CADD package may be lost or modified when the “neutral” file is imported.

The electronic linkage between graphic and nongraphic elements may be lost when converting a file to a “neutral” file exchange format. Different CADD packages have different ways of storing nongraphic data. Some CADD packages can store a small amount of information with the graphic element in an application-defined format or, alternatively, have one or more electronic linkages to external databases where a larger amount of data can be stored.

The Spatial Data Transfer Standard (SDTS), also Federal Information Processing Standards (FIPS) 173, was approved by the National Institute of Standards and Technology (NIST), for the purpose of providing a “neutral” format for the exchange of graphic and nongraphic geospatial and related data.

The SDTS provides an exchange mechanism for the transfer of spatial data between dissimilar computer systems. The SDTS specifies exchange constraints, addressing formats, structure, and content for spatially referenced vector and raster data. The SDTS was approved as FIPS 173 in July 1992. The FIPS 173 implementation became effective February 15, 1993; use of FIPS 173 as the spatial data transfer mechanism was mandatory for Federal agencies on February 15, 1994. It is also available for use by state and local governments, the private sector, and research and academic organizations.

The U.S. Geological Survey (USGS) is coordinating the development of a set of public domain software tools, including a package designed to support the encoding and decoding of logically compliant SDTS data into and out of the required ISO 8211-FIPS 173 file implementation. When data sets developed using the Spatial Data Standards for facilities, infrastructure, and the environment (SDSFIE) are transferred between dissimilar computer systems, the SDTS may be required.

For additional information about the SDTS, FIPS 173, contact: U.S. Geological Survey, SDTS Task Force, 526 National Center, Reston, VA 22092 (FAX 703-648-5542).

GDS, Map, Database, Project Development, and Plot Configuration Documentation

Complete documentation concerning the development of each finished GDS project, with all maps and associated databases, should be submitted to the Government. All delivered files should be documented with the appropriate documentation program provided with the general cell library. When the documentation program is not available, an ASCII file should be provided. Documentation of the plot file configuration for each drawing is needed to be able to duplicate the plot at a later date and should be provided with the deliverables.

The following information should be included:

- a.* How the data were acquired and input (e.g., keyed in or downloaded from a survey total station, instrument (include name and model)).
- b.* Brief development history for each graphic and nongraphic file (e.g., content, when developed, modified, etc.).
- c.* Reference files and symbols library names. A list and file location of all new symbols created for the project, which were not provided to the consulting firm in the GFM.
- d.* Level/layer assignments and lock settings (where applicable).
- e.* Fonts and line styles/types used.
- f.* Metadata files in the Government approved format.
- g.* Database schema and instructions for its use. A list of all database files associated with each drawing, as well as a description of the database format and schema design.
- h.* Plotting instructions on tape/diskette and paper. Include the plotter configuration (e.g., name and model of plotter), pen settings, and any specific plotting instructions.
- i.* A list of all deviations from the Government's specified or provided standards.
- j.* A list of any non-IGES crosshatch/patterns used.
- k.* Any recommended modifications necessary to make the data available for future use with a different type of GDS or with other "life-cycle" activities.

Hard Copies of Maps

When required by the Government, consulting firms should provide one full-size (or half-size at the preference of the organization) hard copy (usually mylar, paper, or vellum) of each finished drawing with the final submittal. A hard copy of the documentation for each file should also be provided with each submittal on the size and type of media as preferred by the organization and negotiated in the consulting firm contract.

CADD and GIS Integration Considerations

A decision should be made before the initiation of the consulting contracting procedures as to whether or not the survey, mapping, or digital geospatial data will later be used for both CADD and GIS applications. Both technologies can be used to create maps which have a similar outward appearance.

CADD technology treats digital data as electronic drawings that are basically made up of graphic elements organized into “layers” or “levels.” CADD technology has become more sophisticated with the development of the capability to store basic nongraphic data about graphic elements in external databases. This nongraphic data can then be queried for design analysis or facilities management purposes.

GIS technology is more complex because it must accurately store both graphic (map or drawing) and nongraphic (database or attribute) data for analysis and display purposes. GIS technology can be used to simulate extremely complex real-world events and situations.

At most organizations, all digital survey maps and drawings have been prepared using CADD technology. Today, with the growing popularity of GIS technology, the life cycle use of the electronic data should be evaluated in determining the most useful and efficient means for data acquisition and digital map development. Many organizations use CADD technology for the development of digital survey maps whose primary use will be in the development of design (architectural and engineering) drawings for construction-type projects. GIS technology may be used for the development of all maps created specifically for planning, design, operations and maintenance, facility management, and disposal functions where the analysis of stored nongraphic data is the primary concern.

When the CADD-generated data files are to be later translated and used by a GIS, the following guidelines in data structure should be followed:

- a.* The edges of all digitized maps must exactly match digitally with those of all adjacent maps.

- b. The digital representation of the common boundaries for all graphic features must be exactly the same, regardless of level/layer. Each feature within a map theme must be represented by a single graphic element (e.g., polygon, line, or line string).
- c. Lines and line strings which represent the same graphic element must be continuous (i.e., not broken or segmented), unless that segmentation reflects a specific visual line type. Lines/strings representing the same type of data must not cross except at intersections.
- d. Polygons must be closed (i.e., the first x- and y-coordinates must exactly match the last x- and y-coordinates). Each polygon must have a single unique centroid to which attributes (i.e., an attribute table) can be attached. Polygons of the same coverage must not overlap and must cover the area of interest completely (i.e., have no gaps in coverage).
- e. All graphic elements that connect must connect digitally exactly, without overlaps or gaps.
- f. Straight lines must be represented by only the beginning and ending x- and y-coordinate points. Line strings must not cross back on themselves or be of zero length.

Nongraphic Data Criteria

All nongraphic data shall be developed and delivered to the target organization in the format specified in the SDS or A/E/C CADD Standard. In a GIS, nongraphic data (or attribute data) are stored in database tables which provide geospatial and related data concerning the various features shown on maps, and business processes. These tables are called attribute tables.

The GDS software uses electronic linkages to connect the graphic data to attribute tables in the database. Even though different RDMS's and DBMS's behave similarly, they are not normally compatible with one another unless translated.

The type and version of database software package used by the target organization must be addressed in the technical contract documents.

The A-E must provide the nongraphic data in the format which can be directly imported to, displayed and edited within, and output from the database software specified by the Government. Additionally, all linkages of nongraphic data with graphic data, relationships between database tables, and report formats shall be maintained, or automatically reconstructed, when transferred to the GDS software specified by the Government. Not doing so will require the

Government to recreate the linkages, a time-consuming and expensive process. Data files and tables can be transferred in various ways in order to prevent data reentry and its associated costs.

Geospatial Metadata

Provisions should be included in the technical specifications requiring the A-E contractor to prepare and deliver the metadata files along with the final contract deliverables. Internet sources of detailed information concerning the content and format for the metadata files can be obtained from the following URL addresses:

FGDC Internet Homepage - <http://www.fgdc.gov>

FGDC Clearinghouse - <http://www.fgdc.gov/clearinghouse>

FGDC Metadata - <http://www.fgdc.gov/metadata>

USACE Geospatial Data Clearinghouse Node - <http://corpsgeo1.usace.army.mil>

Metadata Creation Software has been developed to assist in the preparation of the required metadata files. Some sources of Metadata Creation Software are:

- USACE Geospatial Clearinghouse Node - CORPSMET is available for download at no cost.
- ArcView 8.x (ESRI) has ArcCatalog for metadata generation.

Appendix A

Sample *FedBizOpps* (FBO) Clauses for CADD Deliverables in AutoCAD Format

NOTE: The following information is provided as guidance in specifying only the CADD-related requirements. Edit as necessary for the specific type(s) of work to be performed. The information provided in bold italics type is to be used in filling in the blanks and should be deleted from the final FedBizOpps clause.

A. GENERAL.

All _____ ***(insert a general description of work to be accomplished using CADD software, e.g., design work, surveying work, drawings, maps, details)*** to be provided under this contract shall be accomplished and developed using computer-aided design and drafting (CADD) software and procedures conforming to the following criteria.

B. GRAPHIC FORMAT.

All CADD data shall be supplied in Autodesk's, three-dimensional, AutoCAD _____ ***(insert 2000, 2002, etc.)***, native electronic digital format (i.e., .dwg). The contractor shall ensure that all digital files and data (e.g., model files, reference files, cell libraries) are compatible with the Government's target CADD system (i.e., basic and advanced CADD software, platform, database software), and adhere to the standards and requirements specified herein. The term "compatible" means that data can be accessed directly by the target CADD system without translation, preprocessing, or postprocessing of the electronic digital data files. It is the responsibility of the contractor to ensure this level of compatibility.

(OPTION 1 - Add when requesting work be accomplished and CADD deliverables be provided to the Government in a specific advanced application software format. Civil Design is included as an example. Delete and add different software packages as they apply).

The contractor shall also produce drawings and models, which are compatible with Autodesk's Civil Design, version _____ ***(insert version used)*** software. This includes full functionality of Civil Design's associated database.

(OPTION 2 - Add when requesting scanning work).

The supplied scanned electronic digital files shall be delivered in the native AutoCAD digital format which is fully compatible with Autodesk's _____, version ____ (*insert version used*), software.

(OPTION 3 - Add when a nongraphical database software is to be used).

The nongraphical database delivered with prepared drawings shall be in ____ (*insert name and version of database software used, e.g., Oracle, Access*), version ____ or higher, format. All linkages of nongraphical data with graphic elements, relationships between database tables, and report formats shall be maintained. All database tables shall conform to the structure and field-naming guidance provided by the Government.

C. CADD STANDARDS.

CADD drawings shall be prepared in accordance with the applicable provisions of the "Architectural/Engineering/Construction (A/E/C) Computer-Aided Design and Drafting (CADD) Standard, Release _____ (*insert Release #*). Standard drawing size shall be _____ (*insert size used by target installation*). _____ (*insert either Inch-pound or SI*) working units and the A/E/C CADD Standard file-naming conventions for model and sheet files shall be used.

(OPTION - The contracting officer may choose to include a summary of the major target installation or job-specific CADD standards to be used as a supplement with the Government-furnished materials, if available). Sample terminology for incorporating this summary into the technical specifications is as follows:

CADD drawings, details, and data shall be prepared in accordance with the specific target installation and job-specific CADD standards included in _____ (*insert document title*), the electronic seed files, the electronic detail library, the electronic symbol library, the electronic text and font library, and the electronic line style/type library provided by the Government. The Contractor shall submit a written request for approval of any deviations from the Government's established CADD standard. No deviations from the Government's established CADD standard will be permitted unless prior written approval of such deviation has been received from the Government.

D. DELIVERY MEDIA AND FORMAT.

A copy of all CADD data and files developed under this contract shall be delivered to the Government on electronic digital media at _____ (*insert the appropriate submittal times, e.g., project completion, with each submittal as required in the Schedule of Work*). For projects with electronic digital files or sets of files less than or equal to four (4) diskettes, the electronic digital data and files may be provided on 3-1/2-inch high-density floppy disks. For projects with electronic digital files or sets of files larger than four (4) diskettes, the electronic digital data and files shall be provided on _____ (*insert one or more of the following: (1) CD-R or CD-RW (CD recordable or CD rewriteable), (2) CD-ROM (compact disc, read only memory), (3) ZIP disk (100 MB or 250 MB), (4) JAZ disk (1GB), (5) LS-120 disk, (6) 8-mm tape cartridge, (7) DLT tape cartridge*). The electronic digital media shall be in a format that can be read and processed by the Government's target CADD system.

The external label for each electronic digital media shall contain, as a minimum, the following

information:

- (1) The Contract Number (and Delivery Order Number if applicable) and date.
- (2) The format and version of operating system software.
- (3) The name and version of utility software used for preparation (e.g., compression/decompression) and copying files to the media.
- (4) The sequence number of the digital media.
- (5) A list of the filenames.

Before a CADD file is placed on the delivery electronic digital media, the following procedures shall be performed:

- (1) Remove all extraneous graphics outside the border area and set the active parameters to a standard setting or those in the Government-furnished seed file.
- (2) Make sure all reference files are attached without device or directory specifications.
- (3) Compress and reduce all design files using _____ ***(insert name and version of file compression/decompression software used by Government)***, or other compatible file compression/decompression software approved by the Contracting Officer. If the file compression/decompression software is different from that specified above, then an electronic digital media copy of the file compression/decompression software shall be purchased for the Government and provided to the Government with the delivery media.
- (4) Include all files, both graphic and nongraphic, required for the project (i.e., color tables, pen tables, font libraries, blocks, user command files, plot files). All blocks not provided as Government-furnished materials must be provided to the Government as a part of the electronic digital deliverables.
- (5) Make sure that all support files such as those listed above are in the same directory and that references to those files do not include device or directory specifications.
- (6) Include any standard sheets (i.e., abbreviation sheets, standard symbol sheets) necessary for a complete project.
- (7) Document any fonts, tables, etc., developed by the A-E or not provided among the Government-furnished materials. The contractor shall obtain Government approval before using anything other than the Government's standard fonts, linetypes, tables, or cells.
- (8) Each finished drawing (sheet) shall have its own separate plot file. The plot file for each finished drawing shall be provided to the Government in a _____ ***(insert name, model, and other specifications for the specific plotter configuration used by the Government target installation)*** plotter configuration.

E. DRAWING DEVELOPMENT DOCUMENTATION.

Complete documentation concerning the development of each finished drawing shall be included in the first eight layers as described in the “A/E/C CADD Standard.” The following additional information for each finished drawing shall also be included in the nonplot layer, X-ANNO-NPLT:

- (1) How the data were input (e.g., keyed in, downloaded from a survey total station instrument (include name and model)).
- (2) Brief drawing development history (e.g., date started, modification date(s) with brief description of item(s) modified, author's name).
- (3) The names of the reference files, blocks, symbols, details, tables, and schedule files required for the finished drawing.
- (4) Layer assignments and lock settings.
- (5) Text fonts, line styles used, and pen settings.

F. HARD COPY TRANSMITTALS.

A transmittal letter shall accompany each electronic digital media submittal to the Government. The transmittal letter shall be dated and signed by the appropriate Contractor's representative. The transmittal letter shall be provided to the Government on 8-1/2-inch by 11-inch paper. An electronic copy of the transmittal letter in a _____ (*insert type of format required, e.g., ASCII Text, Word*) format shall also be provided on the electronic digital media submitted to the Government. The transmittal letter shall contain, as a minimum, the following information:

- (1) The information included on the external label of each media unit (e.g., disk, tape), along with the total number being delivered, and a list of the names and descriptions of the files on each media unit.
- (2) Brief instructions for transferring the files from the media.
- (3) Certification that all delivery media are free of known computer viruses. A statement including the name(s) and release date(s) of the virus-scanning software used to analyze the delivery media, the date the virus scan was performed, and the operator's name shall also be included with the certification. The release or version date of the virus-scanning software shall be the current version which has detected the latest known viruses at the time of delivery of the digital media.
- (4) A statement indicating that the A-E will retain a copy of all delivered electronic digital media (with all files included) for at least one year and, during this period of time, will provide up to _____ (*insert number of copies which may be needed, e.g., two*) additional copies of each to the Government, if requested, at no additional cost.

In addition, the Contractor shall provide the following “Plot File Development and Project Documentation Information” as an enclosure or attachment to the transmittal letter provided with each electronic digital media submittal. The “Plot file Development and Project Documentation Information” shall be provided to the Government on 8-1/2-inch by 11-inch paper. An electronic copy of this information in a _____ (*insert type of format required, e.g., ASCII Text, Word*) format shall also be provided on the electronic digital media submitted to the Government.

- (1) Documentation of the plot file for each drawing which will be needed to be able to duplicate the creation of the plot file by the Government at a later date. This documentation shall include the plotter configuration (e.g., name and model of plotter), pen settings, drawing orientation, drawing size, and any other special instructions.
- (2) Instructions concerning how to generate plotted, or hard copy, drawings from the provided plot files.
- (3) List of any deviations from the Government's standard layer scheme and file-naming conventions.
- (4) List of all new symbol blocks created for the project, which were not provided to the Contractor with the Government-furnished materials.
- (5) List of any non-IGES patterns used.
- (6) List of all new figures, symbols, tables, schedules, details, and other blocks created for the project, which were not provided to the Contractor with the Government-furnished materials, and any associated properties.
- (7) List of all database files associated with each drawing, as well as a description and documentation of the database format and schema design.
- (8) Recommended modifications which will be necessary to make the data available for GIS use.

The Contractor shall also provide _____ (*insert number of copies*) _____ (*insert either full-size or half-size*) _____ (*insert either mylar, paper, or vellum*) hard copy(ies) of each finished drawing with each electronic digital media submittal to the Government.

G. OWNERSHIP.

The Government, for itself and such others as it deems appropriate, will have unlimited rights under this contract to all information and materials developed under this contract and furnished to the Government and documentation thereof, reports, and listings, and all other items pertaining to the work and services pursuant to this agreement including any copyright. Unlimited rights under this contract are rights to use, duplicate, or disclose text, data, drawings, and information, in whole or in part in any manner and for any purpose whatsoever without compensation to or approval from the Contractor. The Government will at all reasonable times have the right to inspect the work and will have access to and the right to make copies of the above-mentioned items. All text, electronic digital files, data, and other products generated under this contract shall become the property of the Government. By reference, the following DFAR clauses are included in this contract as a part of the requirements herein:

- a. DFAR 252.227-7013, "Rights in Technical Data - Noncommercial Items."
- b. DFAR 252.227-7017, "Identification and Assertion of Use, Release, or Disclosure Restrictions."
- c. DFAR 252.227-7020, "Rights in Special Works."
- d. DFAR 252.227-7028, "Technical Data or Computer Software Previously Delivered to the

Government.”

- e. DFAR 252.227-7037, “Validation of Restrictive Markings on Technical Data.”
- f. DFAR 252.227-7025, “Limitations on the Use or Disclosure of Government-Furnished Information Marked with Restrictive Legends.”
- g. DFAR 252.227-7014, “Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation.”

H. GOVERNMENT-FURNISHED MATERIALS.

(1) Electronic (.pdf) copy of latest version of “A/E/C CADD Standard.”

(2) Electronic prototype drawings containing the Government's preset standard settings, or work-spaces (e.g., working units, color table library, line style library, level structures, text font library, blocks), for use by the Contractor. The prototype drawings will be provided on _____ (insert type of digital media).

(3) Electronic reference files containing the Government's standard border sheets. Reference files will be provided on _____ (insert type of digital media).

(4) Guidance for development of database files.

(5) Electronic cells or reference files containing the Government's standard project details on _____ (insert type of digital media).

(6) One hard copy of “_____” (insert the name of the target installation's and job-specific CADD standard).

Appendix B

Sample *FedBizOpps* (FBO) Clauses for CADD Deliverables in MicroStation Format

NOTE: The following information is provided as guidance in specifying only the CADD-related requirements. Edit as necessary for the specific type(s) of work to be performed. The information provided in bold italics type is to be used in filling in the blanks and should be deleted from the final FedBizOpps clauses.

A. GENERAL.

All _____ ***(insert a general description of work to be accomplished using CADD software, e.g., design work, surveying work, drawings, maps, details)*** to be provided under this contract shall be accomplished and developed using computer-aided design and drafting (CADD) software and procedures conforming to the following criteria.

B. GRAPHIC FORMAT.

All CADD data shall be supplied in Bentley Systems, three-dimensional, MicroStation _____ ***(insert SE, J, or v8)***, native electronic digital format (i.e., .dgn, .cel). The contractor shall ensure that all digital files and data (e.g., model files, reference files, cell libraries) are compatible with the Government's target CADD system (i.e., basic and advanced CADD software, platform, database software), and adhere to the standards and requirements specified herein. The term "compatible" means that data can be accessed directly by the target CADD system without translation, preprocessing, or postprocessing of the electronic digital data files. It is the responsibility of the contractor to ensure this level of compatibility.

(OPTION 1 - Add when requesting work be accomplished and CADD deliverables be provided to the Government in a specific advanced application software format. TriForma and InRoads are included as examples. Delete and add different software packages as they apply).

The contractor shall also produce drawings and models, which are compatible with Bentley System's TriForma, version _____ ***(insert version used)***, and InRoads, version _____ ***(insert version used)***, software. This includes full functionality of TriForma's associated database.

(OPTION 2 - Add when requesting scanning work).

The supplied scanned electronic digital files shall be delivered in the native MicroStation digital format which is fully compatible with Bentley System's I/RAS B, version ____ ***(insert version used)***, software.

(OPTION 3 - Add when a nongraphical database software is to be used).

The nongraphical database delivered with prepared drawings shall be in ____ ***(insert name and version of database software used, e.g., Oracle, Access)***, version ____ or higher, format. All linkages of nongraphical data with graphic elements, relationships between database tables, and report formats shall be maintained. All database tables shall conform to the structure and field-naming guidance provided by the Government.

C. CADD STANDARDS.

CADD drawings shall be prepared in accordance with the applicable provisions of the "Architectural/Engineering/Construction (A/E/C) Computer-Aided Design and Drafting (CADD) Standard, Release ____ ***(insert Release #)***." Standard drawing size shall be ____ ***(insert size used by target installation)***. ____ ***(insert either Inch-pound or SI)*** working units and the A/E/C CADD Standard file-naming conventions for model and sheet files shall be used.

(OPTION - The contracting officer may choose to include a summary of the major target installation or job-specific CADD standards to be used as a supplement with the Government-furnished materials, if available). Sample terminology for incorporating this summary into the technical specifications is as follows:

CADD drawings, details, and data shall be prepared in accordance with the specific target installation and job-specific CADD standards included in ____ ***(insert document title)***, the electronic seed files, the electronic detail library, the electronic symbol library, the electronic text and font library, and the electronic line style/type library provided by the Government. The Contractor shall submit a written request for approval of any deviations from the Government's established CADD standard. No deviations from the Government's established CADD standard will be permitted unless prior written approval of such deviation has been received from the Government.

D. DELIVERY MEDIA AND FORMAT.

A copy of all CADD data and files developed under this contract shall be delivered to the Government on electronic digital media at ____ ***(insert the appropriate submittal times, e.g., project completion, with each submittal as required in the Schedule of Work)***. For projects with electronic digital files or sets of files less than or equal to four (4) diskettes, the electronic digital data and files may be provided on 3-1/2-inch high-density floppy disks. For projects with electronic digital files or sets of files larger than four (4) diskettes, the electronic digital data and files shall be provided on ____ ***(insert one or more of the following: (1) CD-R or CD-RW (CD recordable or CD rewriteable), (2) CD-ROM (compact disc, read only memory), (3) ZIP disk (100 MB or 250 MB), (4) JAZ disk (1GB), (5) LS-120 disk, (6) 8-mm tape cartridge, (7) DLT tape cartridge)***. The electronic digital media shall be in a format that can be read and processed by the Government's target CADD system.

The external label for each electronic digital media shall contain, as a minimum, the following information:

- (1) The Contract Number (and Delivery Order Number if applicable) and date.
- (2) The format and version of operating system software.
- (3) The name and version of utility software used for preparation (e.g., compression/decompression) and copying files to the media.
- (4) The sequence number of the digital media.
- (5) A list of the filenames.

Before a CADD file is placed on the delivery electronic digital media, the following procedures shall be performed:

- (1) Remove all extraneous graphics outside the border area and set the active parameters to a standard setting or those in the Government-furnished seed file.
- (2) Make sure all reference files are attached without device or directory specifications.
- (3) Compress and reduce all design files using _____ ***(insert name and version of file compression/decompression software used by Government)***, or other compatible file compression/decompression software approved by the Contracting Officer. If the file compression/decompression software is different from that specified above, then an electronic digital media copy of the file compression/decompression software shall be purchased for the Government and provided to the Government with the delivery media.
- (4) Include all files, both graphic and nongraphic, required for the project (i.e., color tables, pen tables, font libraries, cell libraries, user command files, plot files). All cells not provided as Government-furnished materials must be provided to the Government as a part of the electronic digital deliverables.
- (5) Make sure that all support files such as those listed above are in the same directory and that references to those files do not include device or directory specifications.
- (6) Include any standard sheets (i.e., abbreviation sheets, standard symbol sheets) necessary for a complete project.
- (7) Document any fonts, tables, etc., developed by the A-E or not provided among the Government-furnished materials. The contractor shall obtain Government approval before using anything other than the Government's standard fonts, linetypes, tables, or cells.
- (8) Each finished drawing (sheet) shall have its own separate plot file. The plot file for each finished drawing shall be provided to the Government in a _____ ***(insert name, model, and other specifications for the specific plotter configuration used by the Government target installation)*** plotter configuration.

E. DRAWING DEVELOPMENT DOCUMENTATION.

Complete documentation concerning the development of each finished drawing shall be included in the first eight levels as described in the “A/E/C CADD Standard.” The following additional information for each finished drawing shall also be included in the nonplot level, X-ANNO-NPLT:

- (1) How the data were input (e.g., keyed in, downloaded from a survey total station instrument (include name and model)).
- (2) Brief drawing development history (e.g., date started, modification date(s) with brief description of item(s) modified, author's name).
- (3) The names of the reference files, cells, symbols, details, tables, and schedule files required for the finished drawing.
- (4) Level assignments and lock settings.
- (5) Text fonts, line styles used, and pen settings.

F. HARD COPY TRANSMITTALS.

A transmittal letter shall accompany each electronic digital media submittal to the Government. The transmittal letter shall be dated and signed by the appropriate Contractor's representative. The transmittal letter shall be provided to the Government on 8-1/2-inch by 11-inch paper. An electronic copy of the transmittal letter in a _____ (*insert type of format required, e.g., ASCII Text, Word*) format shall also be provided on the electronic digital media submitted to the Government. The transmittal letter shall contain, as a minimum, the following information:

- (1) The information included on the external label of each media unit (e.g., disk, tape), along with the total number being delivered, and a list of the names and descriptions of the files on each media unit.
- (2) Brief instructions for transferring the files from the media.
- (3) Certification that all delivery media are free of known computer viruses. A statement including the name(s) and release date(s) of the virus-scanning software used to analyze the delivery media, the date the virus scan was performed, and the operator's name shall also be included with the certification. The release or version date of the virus-scanning software shall be the current version which has detected the latest known viruses at the time of delivery of the digital media.
- (4) A statement indicating that the A-E will retain a copy of all delivered electronic digital media (with all files included) for at least one year and, during this period of time, will provide up to _____ (*insert number of copies which may be needed, e.g., two*) additional copies of each to the Government, if requested, at no additional cost.

In addition, the Contractor shall provide the following “Plot File Development and Project Documentation Information” as an enclosure or attachment to the transmittal letter provided with each electronic digital media submittal. The “Plot file Development and Project Documentation Information” shall be provided to the Government on 8-1/2-inch by 11-inch paper. An electronic copy of this information in a _____ (*insert type of format required, e.g., ASCII Text, Word*) format shall also be provided on the electronic digital media submitted to the Government.

- (1) Documentation of the plot file for each drawing which will be needed to be able to duplicate the creation of the plot file by the Government at a later date. This documentation shall include the plotter configuration (e.g., name and model of plotter), pen settings, drawing orientation, drawing size, and any other special instructions.
- (2) Instructions concerning how to generate plotted, or hard copy, drawings from the provided plot files.
- (3) List of any deviations from the Government's standard level scheme and file-naming conventions.
- (4) List of all new symbol cells created for the project, which were not provided to the Contractor with the Government-furnished materials.
- (5) List of any non-IGES patterns used.
- (6) List of all new figures, symbols, tables, schedules, details, and other cells created for the project, which were not provided to the Contractor with the Government-furnished materials, and any associated properties.
- (7) List of all database files associated with each drawing, as well as a description and documentation of the database format and schema design.
- (8) Recommended modifications which will be necessary to make the data available for GIS use.

The Contractor shall also provide _____ (*insert number of copies*) _____ (*insert either full-size or half-size*) _____ (*insert either mylar, paper, or vellum*) hard copy(ies) of each finished drawing with each electronic digital media submittal to the Government.

G. OWNERSHIP.

The Government, for itself and such others as it deems appropriate, will have unlimited rights under this contract to all information and materials developed under this contract and furnished to the Government and documentation thereof, reports, and listings, and all other items pertaining to the work and services pursuant to this agreement including any copyright. Unlimited rights under this contract are rights to use, duplicate, or disclose text, data, drawings, and information, in whole or in part in any manner and for any purpose whatsoever without compensation to or approval from the Contractor. The Government will at all reasonable times have the right to inspect the work and will have access to and the right to make copies of the above-mentioned items. All text, electronic digital files, data, and other products generated under this contract shall become the property of the Government. By reference, the following DFAR clauses are included in this contract as a part of the requirements herein:

- a. DFAR 252.227-7013, "Rights in Technical Data - Noncommercial Items."
- b. DFAR 252.227-7017, "Identification and Assertion of Use, Release, or Disclosure Restrictions."
- c. DFAR 252.227-7020, "Rights in Special Works."
- d. DFAR 252.227-7028, "Technical Data or Computer Software Previously Delivered to the Government."

- e. DFAR 252.227-7037, "Validation of Restrictive Markings on Technical Data."
- f. DFAR 252.227-7025, "Limitations on the Use or Disclosure of Government-Furnished Information Marked with Restrictive Legends."
- g. DFAR 252.227-7014, "Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation."

H. GOVERNMENT-FURNISHED MATERIALS.

(1) Electronic (.pdf) copy of latest version of "A/E/C CADD Standard."

(2) Electronic seed files containing the Government's preset standard settings, or workspaces (e.g., working units, color table library, line style library, level structures, text font library, symbol cells), for use by the Contractor. The seed files will be provided on _____ (insert type of digital media).

(3) Electronic reference files containing the Government's standard border sheets. Reference files will be provided on _____ (insert type of digital media).

(4) Guidance for development of database files.

(5) Electronic cells or reference files containing the Government's standard project details on _____ (insert type of digital media).

(6) One hard copy of "_____ " (insert the name of the target installation's and job-specific CADD standard).

Appendix C

Sample *FedBizOpps* (FBO) Clauses for GIS Deliverables in ESRI Format

NOTE: The following information is provided as guidance in specifying products and/or related services specific to geospatial and related data requirements. Edit as necessary for the specific type(s) of work to be performed. The information provided in bold italics type should be used in filling in the blanks and should be deleted from the final FBO clause. The examples provided are not all-inclusive and are intended to directly relate to standard FBO solicitation format described in the Federal Acquisition Regulations (FAR). This does not include all contractual language required before synopsis.

Block 17 of FBO.

GENERAL CONTRACT INFORMATION:

Architect engineer (A-E) services are required for _____ (*input desired number of contracts*) Indefinite Delivery Contract (s) for _____ (*insert desired services - Geographic Information System (GIS), surveying, mapping, aerial photography, hydrographic surveying, etc.*) in support of the missions of _____ (*name of organization and/or project*).

Work shall include _____ (*select from the list below to describe main items or required services under the proposed contract:*

1. *Geographic Information System (GIS) planning, development, maintenance, programming, including GIS based analysis and map production.*
2. *Hydrographic surveying of rivers, ports, open ocean, bays, channels, and lakes*
3. *Topographic mapping*
4. *Drawing/map conversion, raster scanning/vector conversion*

5. *High-order geodetic control (horizontal and vertical) surveys using differential Global Positioning System and conventional survey techniques, for control, and property/boundary surveys.*
6. *Controlled and noncontrolled aerial photography and photo processing*
7. *Photogrammetric mapping including aero-triangulation*
8. *Finish map (color and black-and-white) publishing or production from GIS datasets and softwares*
9. *Digital-orthophotography image file and map production*
10. *Remote sensing, radar, and satellite imagery*
11. *Large-format map and/or aerial imagery document production*

Primary work assignments are for the _____ *(Project/District/ Installation and their assignments and/or describe the geographic region where the services will be directed/performed. In the case of GIS, this may not matter. Be specific, if for no other reason but to keep Government costs down specific to travel and per diem.)*

This contract will be accomplished by separate delivery orders not to exceed _____ *(insert dollar amount)* each with a total cumulative amount of the contract, not to exceed _____ *(insert dollar amount)* for a one-year period with an option for an additional _____ *(insert number of years)* -year extension to the contract for an additional _____ *(insert dollar amount)*. The estimated start date of the contract is _____ *(insert date)*.

Work shall be accomplished in full compliance with established agency manuals, health and safety requirements and other policies as necessitated by special site conditions or job requirements. All services shall be supervised by an experienced _____ *(insert desired text - GIS Specialist, Land Surveyor(s) licensed in the state(s) of <insert - desired state>, and/or In-Shore Hydrographer(s)).*

SPECIFIC SERVICES REQUIRED:

The contractor shall be required to provide professional services specific to the acquisition of geospatial data and geospatial database and map development. Work shall include, but not be limited to: (1) Geographic Information System (GIS) development; (2) Geospatial data acquisition through the accomplishment of topographic, hydrographic, and/or cadastral/real estate surveys; (3) Geospatial data acquisition through the use of global positioning system (GPS) technology; (4) Photogrammetric and digital orthophotography mapping; (5) Conversion of existing paper maps/drawings to digital vector file formats (through scanning and

heads-up digitizing); and (6) Conversion of maps and drawings from various raster or vector formats (e.g., different CADD or GIS digital formats) to the ESRI ArcGIS geodatabase platform. All GIS development (including geospatial data acquisition and map development for use in a GIS) shall conform to the most current release of the Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE). The most current release of the SDSFIE is available for download from the CADD/GIS Technology Center's Internet Website (<http://tsc.wes.army.mil>). All delivered digital GIS data files shall also be submitted in strict compliance with the SDSFIE for the target GIS software system (i.e., the most current version of ESRI ArcGIS).

The contractor shall be required to provide professional services specific to the use and application of ESRI ArcGIS, including all components and extensions. The ArcGIS components and extensions shall include, but not be limited to, ArcView, ArcEditor, ArcInfo, ArcReader, ArcPac, ArcScene, ArcObjects, ArcSDE, ArcIMS, and relational database management system (RDMS) software (e.g., Microsoft Access and SQL Server, Oracle, and IBM Informix). The contractor will be required to provide digital products directly supported by ArcGIS with no intermediate file translation required.

The contractor shall have the capability to submit digital products or deliverables on read-only memory (CD-ROM).

The Government will only accept the final product for full operation, without conversion or reformatting, in the target software format, for use on the target platform specified herein. The target platform is a _____ **(insert name and model of computer hardware)**, with a _____ **(insert name and version of operating system, e.g., Microsoft Windows 2000, Microsoft Windows XP, UNIX, etc.)** operating system.

SELECTION CRITERIA:

The following guidance should be noted when generating this portion of the synopsis.

a. Regulatory Requirements. FAR 36.602-1 (a) and DFARS 236.602-1 (a)(6) specify the general A-E selection criteria. DFARS 236.602-1 (a)(6) emphasizes that "the primary factor in A-E selection is the determination of the most highly qualified firm," and that secondary factors should not be given greater significance than technical qualifications and past performance.

b. Specific Project Criteria. DFARS 236.602-1(a)(i) requires that a synopsis state the order of importance of the selection criteria and that the criteria be project specific. Specific project criteria should be stated in the context of the general FAR and DFARS criteria. Reference to FBO Numbered Note 24 (listed in the FBO Reader's Guide in all Monday editions) is not a sufficient description of project selection criteria.

c. Application of Selection Criteria. Boards will evaluate firms' qualifications strictly on the basis of the announced selection criteria only, and their stated order of importance. The criteria will be applied as follows:

(1) Professional Qualifications (FAR 36.602-1(a)(1)). Professional qualifications is a primary selection criterion. A board will evaluate, as appropriate, the education, training, registration, overall and relevant experience, and longevity with the firm of the key management and technical personnel. This criterion is primarily concerned with the qualifications of the key personnel and not the number of personnel, which is addressed under the capacity criterion.

(2) Specialized Experience and Technical Competence (FAR 36.602-1(a)(2)). Specialized experience and technical competence is a primary selection criterion. A board will evaluate the specialized experience on similar projects and the technical capabilities (such as design quality management procedures, computer-aided design and drafting, equipment resources, and laboratory certifications) of the prime firm and any subcontractors. The effectiveness of the proposed project team (management structure and coordination of disciplines, offices and/or subcontractors) should also be examined. Prior experience among a prime firm and important subcontractors may also be considered when it is critical to the performance of the work and has been stated in the synopsis.

(3) Capacity (FAR 36 602-1(a)(3)). Capacity is a primary selection criterion. A board will consider a firm's experience with similar size projects and the available capacity of key disciplines when evaluating the capacity of a firm to perform the work in the required time. Since it may be difficult for a firm to accurately predict the staffing requirements for each discipline based on the information in a FBO synopsis, a firm should not be disqualified or downgraded because of its proposed personnel strengths for a project in Block 4 of the SF 255. Instead, an evaluation board should consider the total strength of key disciplines in the prime firm and its consultants, as shown on the SFs 254, in relationship to the firm's workloads.

(4) Past Performance (FAR 36.602-1(a)(4)). If applicable to your agency, past performance is a primary selection criterion. The U.S. Army Corps of Engineers Architect Engineer Contract Administration Support System (ACASS) is the primary source of information on past performance (DFARS 236.602-1(a)(4)) and will be queried for all firms. Complete performance evaluations, not just summary ratings, will be retrieved and reviewed by evaluation boards. Evaluations of any significant subcontractors who have previously been prime contractors should also be retrieved and reviewed. Any credible, documented evaluations may be considered, but a board is not required to seek other independent information on the past performance of a firm if none is available from ACASS. A board will consider the relevancy and correctness of each performance evaluation to the required type of work, including whether subsequent evaluations indicate a change in a firm's performance. A firm that has earned excellent performance evaluations on recent DoD A-E contracts for

similar projects will be ranked relatively higher on past performance (DFARS 236.602-1(a)(6)(B)). The review of performance evaluations in ACASS satisfies the requirements of FAR 9.104-1(c) for reviewing the responsibility of prospective contractors.

(5) Geographic Proximity and Knowledge of the Locality (FAR 36.602-1(a)(5)). The two parts of this criterion must be considered separately since geographic proximity is a secondary criterion in accordance with DFARS 236.602-1(a)(6) and knowledge of the locality is a primary criterion.

(a) Geographic Proximity. Proximity is simply the physical location of a firm in relation to the location of a project, and has little to do with the technical ability of a firm to perform the project. Hence, proximity should normally only be used as a selection criterion for small or routine projects and Indefinite Delivery (ID) contracts in support of a specific installation(s). If proximity is used as a criterion, it will not be applied by a preselection board and will only be used by a selection board as a “tie-breaker” (see paragraph 13.e), if necessary, in ranking the most highly qualified firms.

(b) Knowledge of the Locality. Knowledge of the locality is a primary selection criteria. Specific requirements for knowledge related to the project locality, such as geological features, climatic conditions, or local construction methods, will be considered separate from geographic proximity.

(6) SB and SDB Participation (DFARS 236.602-1(a)(6)(C)). The extent of participation of SB, SDB, historically black colleges and universities (HBCU), and minority institutions (MI) is a secondary selection criterion and will only be applied by a selection board as a “tie-breaker” (see paragraph 13.e), if necessary, in ranking the most highly qualified firms. Participation will be measured as a percentage of the total anticipated contract effort, regardless of whether the SB, SDB, HBCU, or MI is a prime contractor, subcontractor, or joint venture partner, the greater the participation, the greater the consideration.

(7) Volume of DoD Contract Awards (DFARS 236.602-1(a)(6)(A)). The DFARS states “do not reject the overall most highly qualified firm solely in the interest of equitable distribution of contracts.” Hence, equitable distribution of DoD contracts is a secondary criterion and will only be applied by a selection board as a “tie-breaker” (see paragraph 13.e), if necessary, in ranking the most highly qualified firms. DoD A-E contract awards can be obtained from ACASS, and verified and updated during the interviews with the most highly qualified firms. The synopsis may also request firms to submit DoD contract award data in block 10 of SF 255.

SELECTION CRITERIA SYNOPSIS LANGUAGE:

- a. See note 24 (footnote 1 - Note 24 is in direct reference to Commerce Business Daily Numbered

Notes which are published in the FBO periodical. The note expresses an interest in receiving a submission, describes the means by which the selection shall be made and describes the requires for that submission, i.e. forms, etc.) for the general selection process. The selection criteria in descending order of importance are:

(a) Professional qualifications necessary for satisfactory performance of required services: Specialized expertise and technical competence in _____ *(describe fields).*

(b) Specialized experience and technical qualifications:
_____. *(insert appropriate selection criteria from the following optional paragraphs. Modify accordingly to meet your requirements and order of importance.)*

GIS

(Option) Firms with experience and proven technical expertise in GIS planning, implementation, programming, and maintenance using ESRI ArcGIS software. The term ArcGIS software shall also include, but not be limited to: ArcView, ArcEditor, ArcInfo, ArcReader, ArcPad, ArcScene, ArcObjects, ArcSDE, ArcIMS, and relational database management system (RDMS) software (e.g., Microsoft Access and SQL Server, Oracle, and IBM Informix).

(Option) Firms with specialized experience and technical expertise in the creation of three-dimensional digital databases derived from photogrammetric, field survey (total stations), and hydrographic methods compatible with Bentley CADD and ESRI GIS software.

(Option) Firms with specialized expertise and technical competence in producing viewable database information through GIS software viewers and finish presentation quality documents as a result of GIS software queries and analysis.

(Option) Firms with specialized experience and technical expertise in the creation of two-dimensional digital databases derived from CADD vectorization, which includes, but is not limited to, digital image analysis, heads-up-digitizing, drawing conversion (scanning/vectorization processes), photogrammetric map compilation and hydrographic surveying, to products compatible with Bentley CADD and ESRI GIS software.

(Option) Firms with specialized experience and technical expertise in providing quality control for the digitizing and preparing of thematic database data compatible with ESRI ArcGIS.

(Option) Firms with specialized experience and technical expertise in Comprehensive or Master Planning AM/FM.

DRAWING CONVERSION (SCANNING/VECTORIZATION)

(Option) Firms with specialized experience and technical expertise in document conversion utilizing large-format scanning technologies and related applications for the purpose of converting existing hard-copy drawings into GIS-quality thematic features.

SURVEYING, GEODETIC, TOPOGRAPHIC, BOUNDARY

(Option) Firms with specialized experience and technical competence in topographic surveying, geodetic control surveying, precision static and kinematic GPS surveying, cadastral surveying, and boundary surveying with CADD and GIS expertise.

SURVEYING, HYDROGRAPHIC

(Option) Firms with specialized experience and technical competence in hydrographic surveying of rivers, ports, harbors, revetments, dikes, and inland navigation projects. Experience shall fully exemplify the use and expertise of fully automated, digital methods of data collection, processing, and production of resulting bathymetric mapping.

(Option) Firms composed of experienced hydrographers and licensed and professional land surveyors having expertise in survey and mapping technology procedures; capability and specialized experience in the production of thematic mapping using Intergraph system softwares.

(Option) Firms with specialized experience and technical competence in multibeam bathymetry, including production of resulting thematic mapping using ArcGIS systems software. Must exemplify specialized experience in production of computations and/or editing finish data-sets through established and proven computational procedures. Must exemplify direct examples of completed jobs of this type in order to be considered.

(Option) Firms composed of vessel operator(s) having expert knowledge sufficient to operate or navigate passenger-carrying vessels.

(Option) Firms that presently have, or the capability to readily obtain through purchase or lease, an automated hydrographic survey vessel of 19- to 30-foot length capable of being trailered to and operating in inland and coastal navigation projects. The vessel must have a capability for being optionally equipped with full motion compensation, side-scan sonar imaging for underwater hazardous object strike detection, multibeam, shallow-water acoustic imagery from a single transducer source using GPS radio beacon and/or differential corrected GPS positioning to submeter accuracy.

(Option) Firms that presently have, or the capability to readily obtain through purchase or lease, an automated hydrographic survey vessel, capable of performing depth measurements with precision horizontal positioning, in shallow-draft areas of rivers and backwater areas. Must be capable of being trailered to and operating in inland streams and backwater areas.

PHOTOGRAMMETRIC MAPPING

(Option) Firms composed of experienced photogrammetrists who are members of the American Society for Photogrammetry and Remote Sensing (ASPRS), having expertise in survey and mapping technology procedures, and capability and specialized experience in the production of thematic mapping using Intergraph system softwares.

(Option) Firms with specialized expertise and technical competence in the accomplishment of aerial photography through the use of precise aerial cameras.

(Option) Firms with specialized expertise and technical competence in the

production of digital orthophotography, providing georeferenced digital images compatible with ArcInfo GIS software. Also must exemplify the capability to provide large format hard-copy outputs of the same.

(Option) Firms with specialized expertise and technical competence in the production of GIS-quality, stereo-compiled thematic mapping, directly compatible with ArcInfo GIS software.

(Option) Firms with specialized expertise and technical competence in the accomplishment of aero-triangulation.

(Option) Firms with specialized expertise and technical competence in photographic reproduction capabilities, both in color and panchromatic film. Must exemplify direct examples of the ability to conform to quality specifications.

(Option) Firms with specialized expertise and technical competence in aerial GPS techniques and applications specific to the production of strip or block aero-triangulation.

OTHER REQUIREMENTS - PERSONNEL

(Option) Firms composed of specialists having expertise in hydrographic, topographic, geodetic control, boundary surveying; expertise in kinematic and high accuracy GPS surveying, and experience in field data processing and survey adjustments.

(Option) Firms composed of specialists having expertise in survey and site design CADD routines, and experience in interfacing sensors and data collection systems (echo sounders, positioning systems, etc.) with Windows (NT, 2000, or XP) or UNIX-based systems.

OTHER

(Option) Firms which have demonstrated capability to submit all work in hard-copy report format, hard copy "F" size engineer drawings, ArcGIS and associated RDMS digital GIS format.

(Option) Firms which possess or have the capability to readily obtain through purchase or lease, GPS equipment capable of subcentimeter accuracy, utilize the latest static and kinematic technology, and currently employ CADD/GIS data-processing equipment.

(c) Proposed project organization, lines of authority, disciplines proposed, and team backup personnel

(d) Demonstrated capability and capacity of the firm to perform the above-mentioned work to meet short suspense dates.

(e) Location in the general geographic region of _____ *(insert description or your requirements that you desire to be considered).*

(f) Past performance on contracts with Government agencies and private industry in terms of cost control, quality of work, and compliance with performance schedules.

(g) Volume of DoD contract awards in the previous 12 months, as described in note 24 24 *(footnote 1 - Note 24 is in direct reference to Commerce Business Daily Numbered Notes which are published in the FBO periodical. The note expresses an interest in receiving a submission, describes the means by which the selection shall be made and describes the requires for that submission, i.e., forms, etc.*).

Appendix D

Sample *FedBizOpps* (FBO) Clauses for GIS Deliverables in Intergraph Format

NOTE: The following information is provided as guidance in specifying products and/or related services specific to geospatial and related data requirements. Edit as necessary for the specific type(s) of work to be performed. The information provided in bold italics type should be used in filling in the blanks and should be deleted from the final FBO clause. The examples provided are not all-inclusive and are intended to directly relate to standard FBO solicitation format described in the Federal Acquisition Regulations (FAR). This does not include all contractual language required before synopsis.

Block 17 of FBO.

GENERAL CONTRACT INFORMATION:

Architect engineer (A-E) services are required for _____ (*input desired number of contracts*) Indefinite Delivery Contract (s) for _____ (*insert desired services - Geographic Information System (GIS), surveying, mapping, aerial photography, hydrographic surveying, etc.*) in support of the missions of _____ (*name of organization and/or project*).

Work shall include _____ (*select from the list below to describe main items or required services under the proposed contract:*

1. *Geographic Information System (GIS) planning, development, maintenance, programming, including GIS based analysis and map production.*
2. *Hydrographic surveying of rivers, ports, open ocean, bays, channels, and lakes.*
3. *Topographic mapping.*
4. *Drawing/map conversion, raster scanning/vector conversion.*
5. *High-order geodetic control (horizontal and vertical) surveys using differential Global Positioning System and conventional survey techniques, for control, and property/boundary surveys.*

6. *Controlled and noncontrolled aerial photography and photo processing*
7. *Photogrammetric mapping including aero-triangulation*
8. *Finish map (color and black-and-white) publishing or production from GIS datasets and softwares*
9. *Digital-orthophotography image file and map production*
10. *Remote sensing, radar, and satellite imagery*
11. *Large-format map and/or aerial imagery document production*

Primary work assignments are for the _____ *(Project/District/ Installation and their assignments and/or describe the geographic region where the services will be directed/performed. In the case of GIS, this may not matter. Be specific, if for no other reason but to keep Government costs down specific to travel and per diem.)*

This contract will be accomplished by separate delivery orders not to exceed _____ *(insert dollar amount)* each with a total cumulative amount of the contract, not to exceed _____ *(insert dollar amount)* for a one-year period with an option for an additional _____ *(insert number of years)* -year extension to the contract for an additional _____ *(insert dollar amount)*. The estimated start date of the contract is _____ *(insert date)*.

Work shall be accomplished in full compliance with established agency manuals, health and safety requirements and other policies as necessitated by special site conditions or job requirements. All services shall be supervised by an experienced _____ *(insert desired text - GIS Specialist, Land Surveyor(s) licensed in the state(s) of _____ <insert - desired state> , and/or In-Shore Hydrographer(s).*

SPECIFIC SERVICES REQUIRED:

The contractor shall be required to provide professional services specific to the acquisition of geospatial data and geospatial database and map development. Work shall include, but not be limited to: (1) Geographic Information System (GIS) development; (2) Geospatial data acquisition through the accomplishment of topographic, hydrographic, and/or cadastral/real estate surveys; (3) Geospatial data acquisition through the use of global positioning system (GPS) technology; (4) Photogrammetric and digital orthophotography mapping; (5) Conversion of existing paper maps/drawings to digital vector file formats (through scanning and heads-up digitizing); and (6) Conversion of maps and drawings from various raster or vector formats (e.g., different CADD or GIS digital formats) to the Intergraph GeoMedia GIS platform. All GIS development (including geospatial data acquisition and map development for use in a GIS) shall conform to the most current release of the Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE). The most current release of the SDSFIE is available for download from the CADD/GIS Technology Center's Internet Website (<http://tsc.wes.army.mil>). All delivered digital GIS data files shall also be submitted in strict compliance with the SDSFIE for the target GIS software system (i.e., the most current version of Intergraph GeoMedia Professional).

The contractor shall be required to provide professional services specific to the use and application of Intergraph GeoMedia Professional including all components and extensions, and relational database management system (RDMS) software (e.g., Microsoft Access and SQL Server, Oracle, and IBM Informix). The contractor will be required to provide digital products directly supported by GeoMedia Professional with no intermediate file translation required.

The contractor shall have the capability to submit digital products or deliverables on read-only memory (CD-ROM).

The Government will only accept the final product for full operation, without conversion or reformatting, in the target software format, for use on the target platform specified herein. The target platform is a _____ **(insert name and model of computer hardware)**, with a _____ **(insert name and version of operating system, e.g., Microsoft Windows 2000, Microsoft Windows XP, UNIX, etc.)** operating system.

SELECTION CRITERIA:

The following guidance should be noted when generating this portion of the synopsis.

a. Regulatory Requirements. FAR 36.602-1 (a) and DFARS 236.602-1 (a)(6) specify the general A-E selection criteria. DFARS 236.602-1 (a)(6) emphasizes that “the primary factor in A-E selection is the determination of the most highly qualified firm,” and that secondary factors should not be given greater significance than technical qualifications and past performance.

b. Specific Project Criteria. DFARS 236.602-1(a)(i) requires that a synopsis state the order of importance of the selection criteria and that the criteria be project specific. Specific project criteria should be stated in the context of the general FAR and DFARS criteria. Reference to FBO Numbered Note 24 (listed in the FBO Reader's Guide in all Monday editions) is not a sufficient description of project selection criteria.

c. Application of Selection Criteria. Boards will evaluate firms' qualifications strictly on the basis of the announced selection criteria only, and their stated order of importance. The criteria will be applied as follows:

(1) Professional Qualifications (FAR 36.602-1(a)(1)). Professional qualifications is a primary selection criterion. A board will evaluate, as appropriate, the education, training, registration, overall and relevant experience, and longevity with the firm of the key management and technical personnel. This criterion is primarily concerned with the qualifications of the key personnel and not the number of personnel, which is addressed under the capacity criterion.

(2) Specialized Experience and Technical Competence (FAR 36.602-1(a)(2)). Specialized experience and technical competence is a primary selection criterion. A board will evaluate the specialized experience on similar projects and the technical capabilities (such as design quality management procedures, computer-aided design and drafting, equipment resources, and laboratory certifications) of the prime firm and any subcontractors. The effectiveness of the proposed project team (management structure and coordination of disciplines, offices and/or subcontractors) should also be examined. Prior experience among a prime firm and important subcontractors may also be considered when it is critical to the performance of the work and has been stated in the synopsis.

(3) Capacity (FAR 36 602-1(a)(3)). Capacity is a primary selection criterion. A board will consider a firm's experience with similar size projects and the available capacity of key disciplines when evaluating the capacity of a firm to perform the work in the required time. Since it may be difficult for a firm to accurately predict the staffing requirements for each discipline based on the information in a FBO synopsis, a firm should not be disqualified or downgraded because of its proposed personnel strengths for a project in Block 4 of the SF 255. Instead, an evaluation board should consider the total strength of key disciplines in the prime firm and its consultants, as shown on the SFs 254, in relationship to the firm's workloads.

(4) Past Performance (FAR 36.602-1(a)(4)). If applicable to your agency, past performance is a primary selection criterion. The U.S. Army Corps of Engineers (USACE) Architect Engineer Contract Administration Support System (ACASS) is the primary source of information on past performance (DFARS 236.602-1(a)(4)) and will be queried for all firms. Complete performance evaluations, not just summary ratings, will be retrieved and reviewed by evaluation boards. Evaluations of any significant subcontractors who have previously been prime contractors should also be retrieved and reviewed. Any credible, documented evaluations may be considered, but a board is not required to seek other independent information on the past performance of a firm if none is available from ACASS. A board will consider the relevancy and correctness of each performance evaluation to the required type of work, including whether subsequent evaluations indicate a change in a firm's performance. A firm that has earned excellent performance evaluations on recent DoD A-E contracts for similar projects will be ranked relatively higher on past performance (DFARS 236.602-1(a)(6)(B)). The review of performance evaluations in ACASS satisfies the requirements of FAR 9.104-1(c) for reviewing the responsibility of prospective contractors.

(5) Geographic Proximity and Knowledge of the Locality (FAR 36.602-1(a)(5)). The two parts of this criterion must be considered separately since geographic proximity is a secondary criterion in accordance with DFARS 236.602-1(a)(6) and knowledge of the locality is a primary criterion.

(a) Geographic Proximity. Proximity is simply the physical location of

a firm in relation to the location of a project, and has little to do with the technical ability of a firm to perform the project. Hence, proximity should normally only be used as a selection criterion for small or routine projects and Indefinite Delivery (ID) contracts in support of a specific installation(s). If proximity is used as a criterion, it will not be applied by a preselection board and will only be used by a selection board as a “tie-breaker” (see paragraph 13.e), if necessary, in ranking the most highly qualified firms.

(b) Knowledge of the Locality. Knowledge of the locality is a primary selection criterion. Specific requirements for knowledge related to the project locality, such as geological features, climatic conditions or local construction methods, will be considered separate from geographic proximity.

(6) SB and SDB Participation (DFARS 236.602-1(a)(6)(C)). The extent of participation of SB, SDB, historically black colleges and universities (HBCU), and minority institutions (MI) is a secondary selection criterion and will only be applied by a selection board as a “tie-breaker” (see paragraph 13.e), if necessary, in ranking the most highly qualified firms. Participation will be measured as a percentage of the total anticipated contract effort, regardless of whether the SB, SDB, HBCU or MI is a prime contractor, subcontractor, or joint venture partner, the greater the participation, the greater the consideration.

(7) Volume of DoD Contract Awards (DFARS 236.602-1(a)(6)(A)). The DFARS states “do not reject the overall most highly qualified firm solely in the interest of equitable distribution of contracts.” Hence, equitable distribution of DoD contracts is a secondary criterion and will only be applied by a selection board as a “tie-breaker” (see paragraph 13.e), if necessary, in ranking the most highly qualified firms. DoD A-E contract awards can be obtained from ACASS, and verified and updated during the interviews with the most highly qualified firms. The synopsis may also request firms to submit DoD contract award data in block 10 of SF 255.

SELECTION CRITERIA SYNOPSIS LANGUAGE:

a. See note 24 (footnote 1 - Note 24 is in direct reference to Commerce Business Daily Numbered Notes which are published in the FBO periodical. The note expresses an interest in receiving a submission, describes the means by which the selection shall be made and describes the requires for that submission, i.e. forms, etc.) for the general selection process. The selection criteria in descending order of importance are:

(a) Professional qualifications necessary for satisfactory performance of required services: Specialized expertise and technical competence in _____ **(describe fields).**

(b) Specialized experience and technical qualifications:
_____. **(insert appropriate selection criteria from the following optional paragraphs. Modify accordingly to meet your requirements and order**

of importance.)

GIS

(Option) Firms with experience and proven technical expertise in GIS planning, implementation, programming, and maintenance using Intergraph GeoMedia Professional, and relational database management system (RDMS) (e.g., Microsoft Access and SQL Server, Oracle, and IBM Informix) software.

(Option) Firms with specialized experience and technical competence with the application of GeoMedia Professional specific to file import of the following: TIGER data, DEM, DLG, DCW, and GBF/DIME.

(Option) Firms with specialized expertise and technical competence in producing viewable database information through GIS software viewers and finish presentation quality documents as a result of GIS software queries and analysis.

(Option) Firms with specialized experience and technical expertise in the creation of three-dimensional digital databases, derived from photogrammetric, field survey (total stations), and hydrographic methods compatible with Intergraph CADD and GIS softwares.

(Option) Firms with specialized experience and technical expertise in the creation of two-dimensional digital databases derived from CADD vectorization, which includes, but is not limited to, digital image analysis, heads-up-digitizing, drawing conversion (scanning/vectorization processes), photogrammetric map compilation and hydrographic surveying, to products compatible with Bentley CADD and Intergraph GIS software.

(Option) Firms with specialized experience and technical expertise in providing quality control for the digitizing and preparing of thematic vector data compatible with _____ **(select appropriate system - Bentley CADD system's MicroStation, version 5 or higher)**

(Option) Firms with specialized experience and technical expertise in Comprehensive or Master Planning AM/FM.

DRAWING CONVERSION (SCANNING/VECTORIZATION)

(Option) Firms with specialized experience and technical expertise in document conversion utilizing large-format scanning technologies and related applications for the purpose of converting existing hard-copy drawings into GIS-quality thematic features.

SURVEYING, GEODETIC, TOPOGRAPHIC, BOUNDARY

(Option) Firms with specialized experience and technical competence in topographic surveying, geodetic control surveying, precision static and kinematic GPS surveying, cadastral surveying, and boundary surveying with CADD and GIS expertise.

SURVEYING, HYDROGRAPHIC

(Option) Firms with specialized experience and technical competence in hydrographic surveying of rivers, ports, harbors, revetments, dikes, and inland navigation projects. Experience shall fully exemplify the use and expertise of

fully automated, digital methods of data collection, processing, and production of resulting bathymetric mapping.

(Option) Firms composed of experienced hydrographers and licensed and professional land surveyors having expertise in survey and mapping technology procedures; capability and specialized experience in the production of thematic mapping using Intergraph system software.

(Option) Firms with specialized experience and technical competence in multibeam bathymetry, including production of resulting thematic mapping using Intergraph CADD/GIS systems software. Must exemplify specialized experience in production of computations and/or editing finish data-sets through established and proven computational procedures. Must exemplify direct examples of completed jobs of this type in order to be considered.

(Option) Firms composed of vessel operator(s) having expert knowledge sufficient to operate or navigate passenger-carrying vessels.

(Option) Firms that presently have, or the capability to readily obtain through purchase or lease, an automated hydrographic survey vessel of 19- to 30-foot length capable of being trailered to and operating in inland and coastal navigation projects. The vessel must have a capability for being optionally equipped with full motion compensation, side-scan sonar imaging for underwater hazardous object strike detection, multibeam, shallow-water acoustic imagery from a single transducer source using GPS radio beacon and/or differential corrected GPS positioning to submeter accuracy.

(Option) Firms that presently have, or the capability to readily obtain through purchase or lease, an automated hydrographic survey vessel, capable of performing depth measurements with precision horizontal positioning, in shallow draft areas of rivers and backwater areas. Must be capable of being trailered to and operating in inland streams and backwater areas.

PHOTOGRAMMETRIC MAPPING

(Option) Firms composed of experienced photogrammetrists who are members of the American Society for Photogrammetry and Remote Sensing (ASPRS), having expertise in survey and mapping technology procedures, and capability and specialized experience in the production of thematic mapping using Intergraph GIS software.

(Option) Firms with specialized expertise and technical competence in the accomplishment of aerial photography through the use of precise aerial camera.

(Option) Firms with specialized expertise and technical competence in the production of digital orthophotography, providing georeferenced digital images compatible with Intergraph GIS software. Also must exemplify the capability to provide large-format hard-copy outputs of the same.

(Option) Firms with specialized expertise and technical competence in the production of GIS-quality, stereo-compiled thematic mapping, directly compatible with Intergraph GIS software.

(Option) Firms with specialized expertise and technical competence in the accomplishment of aero-triangulation.

(Option) Firms with specialized expertise and technical competence in photographic reproduction capabilities both in color and panchromatic film.

Must exemplify direct examples of ability to conform to quality specifications.

(Option) Firms with specialized expertise and technical competence in aerial GPS techniques and applications specific to the production of strip or block aero-triangulation.

OTHER REQUIREMENTS - PERSONNEL

(Option) Firms composed of specialists having expertise in hydrographic, topographic, geodetic control, boundary surveying; expertise in kinematic and high accuracy GPS surveying, and experience in field data processing and survey adjustments.

(Option) Firms composed of specialists having expertise in survey and site design CADD routines, and experience in interfacing sensors and data collection systems (echo sounders, positioning systems, etc.) with DOS, NT, or UNIX-based systems.

OTHER

(Option) Firms which have demonstrated capability to submit all work in hard-copy report format, hard-copy "F" size engineer drawings, Bentley MicroStation digital CADD format, Intergraph GeoMedia digital and associated RDMS digital GIS format.

(Option) Firms which possess or have the capability to readily obtain through purchase or lease, GPS equipment capable of subcentimeter accuracy, utilize the latest static and kinematic technology, and currently employ CADD/ GIS data-processing equipment.

(c) Proposed project organization, lines of authority, disciplines proposed, and team backup personnel.

(d) Demonstrated capability and capacity of the firm to perform the above-mentioned work to meet short suspense dates.

(e) Location in the general geographic region of _____
(insert description or your requirements that you desire to be considered).

(f) Past performance on contracts with Government agencies and private industry in terms of cost control, quality of work, and compliance with performance schedules.

(g) Volume of DoD contract awards in the previous 12 months, as described in note 24 *(footnote 1 - Note 24 is in direct reference to Commerce Business Daily Numbered Notes which are published in the FBO periodical. The note expresses an interest in receiving a submission, describes the means by which the selection shall be made and describes the requires for that submission, i.e., forms, etc.)* .

Appendix E

Sample Technical Contract

Clauses for Surveying, Mapping, and Geographic Information System (GIS) Deliverables

NOTE: The following clauses are included to provide guidance in specifying only the surveying, mapping, and Geographic Information System (GIS) related requirements. Edit as necessary for the specific type(s) of work to be performed. The information provided in bold type is to be used in filling in the blanks and should be deleted from the final contract clauses.

1. GENERAL.

The contractor, operating as an independent contractor and not an agent of the Government, shall provide all labor, material, and equipment necessary to perform the services as stated in this contract. The contractor shall furnish the required personnel, equipment, instruments, and transportation, as necessary to accomplish the required services and furnish to the Government all reports and other data together with supporting material developed during the work efforts. During the prosecution of the work, the contractor shall provide adequate professional supervision and quality control to assure the accuracy, quality, completeness, and progress of the work. All work shall be directed by the “Contracting Officer” or his “Authorized Representative.” The term “Contracting Officer” shall be interpreted to mean “Contracting Officer” or his “Authorized Representative.”

2. LOCATION OF SERVICES.

All _____ *(insert a general list of the different types of work: e.g., surveying, mapping, Geographic Information System (GIS), related geospatial services)* performed under this contract may be required anywhere within the boundaries or

assignments of the _____ *(insert name of Base, Facility, District, Division, installation, area, etc. where the services will be required)*, and shall be directed by the Contracting Officer.

3. SERVICES TO BE PERFORMED.

The general types of professional surveying, mapping, GIS, and related services to be performed under this contract include, but are not limited to, the items listed below.

NOTE: Add, delete, and/or edit from the following list as required.

3.1 GEODETIC CONTROL SURVEYS. Services include horizontal and vertical control surveys for the precise location of primary survey points for planning, engineering, construction, real estate projects, GIS applications, or facility management. These surveys include third-order or higher horizontal and vertical control, geodetic astronomy, gravity, and magnetic surveys in accordance with the Standards and Specifications for Geodetic Control Networks published by the Federal Geodetic Control Committee dated September 1984. Conventional, inertial, satellite, and other traditional precise survey methods as determined to be the most cost-effective means that will achieve the required accuracy of the final product may be used.

3.2 BOUNDARY AND CADASTRAL SURVEYS. These services consist of, but are not limited to, locating, relocating, and/or marking Government boundaries, easements, etc. and preparing or filing/recording certified drawings, computations, deeds, and related descriptive data in accordance with local, state, and Federal requirements, regulations, and laws. Services shall also include all such deed and other research necessary to perform said services.

3.3 TOPOGRAPHIC AND ENGINEERING SURVEYS. Services include but are not limited to field acquisition and office data reduction of detailed topographic and planimetric feature data for use in engineering site planning, cost estimating, design, construction layout and alignment of roads, buildings, and other structures, installation master planning, and recording as-built conditions and GIS applications. Field data acquisition includes both conventional and other methods, such as a planetable, total station, or GPS.

3.4 HYDROGRAPHIC SURVEYS. Services include subsurface surveys of _____ *(input any or all of the following as applicable: channels, rivers, lakes, bays, open coastal waters, etc.)* in support of various types of projects. Services shall include both conventional and automated field data acquisition methods, and subsequent office reduction processes to obtain final spatial data, maps, drawings, or charts. These data may be required for but not limited to _____ *(insert any or all of the following as applicable: planning, cost estimating, engineering, dredging, design, construction, sedimentation, master planning, operations, maintenance, as-built conditions, etc.)*.

3.5 PRECISE MONITORING SURVEYS. Services include but are not limited to precise surveys needed to monitor movements of locks, dams, other structures, and machinery.

3.6 PHOTOGRAMMETRIC SERVICES. Services include but are not limited to the acquisition of aerial photographs, both hard copy and digital, and the compilation of data necessary to generate surveying, mapping, and GIS spatial data products.

3.7 CONVENTIONAL AND/OR DIGITAL MAPPING AND CHARTING SERVICES. Services include the development, implementation, acquisition, and/or generation of conventional and/or digital mapping and charting products. Services include, but are not limited to, two- and three-dimensional mapping and charting, digital terrain models, soft-copy photogrammetry, and GIS products.

3.8 GEOGRAPHIC INFORMATION SYSTEM (GIS) SERVICES. Services include, but are not limited to, the development and implementation of a GIS (hardware, software, data, personnel, approach, procedures, training, etc.) and the production of GIS products (maps, databases, etc.). A GIS consists of an automated computerized system that employs data referenced to a location on the earth, based upon absolute, relative, or assumed coordinates. The target GIS includes the following basic components, which are currently installed, or are to be installed, at the organization which will be receiving and using the geospatial data:

- The platform (computer hardware and operating system).
- The GIS software.
- The relational database management system (RDBMS) software, database schema, and data.
- Digital media containing the organization's graphic and attribute geospatial data.

The digital media are formatted to conform to the organization's GIS standard, and installed to function as an integral part of the GIS. The database of the GIS is "populated" with attribute data. All GIS data (including geospatial data acquisition and map development for use in a GIS) shall conform to the most current release of the Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE). The most current release of the SDSFIE is available for download from the CADD/GIS Technology Center's Internet Website (<http://tsc.wes.army.mil>). All delivered digital GIS data files shall also be submitted in strict compliance with the SDSFIE for the target GIS software system.

3.9 REMOTE SENSING. Services include satellite imagery, film imagery, side-scan sonar, magnetometer, multispectral, SLAR, etc.

4. GRAPHIC FORMAT.

All surveying, mapping, and/or GIS graphical digital data generated by the contractor and supplied to the Government shall be fully compatible with ____, version ____ (*insert name and version of appropriate Target GIS software: e.g., Bentley Geographics; Intergraph GeoMedia Professional; ESRI ArcGIS, Autodesk Map*), native digital format, with a ____, version __ (*insert name and version of Target operating system used: e.g., UNIX, Windows 2000, Windows XP*), operating system. The contractor shall ensure that all digital files and data (e.g., base files, reference files, symbol libraries, etc.) are compatible with the Government's target GIS (i.e., GIS software, operating system, RDBMS software, schema) and adhere to the standards and requirements specified herein. The term "compatible" means that data can be accessed directly by the target system without translation, preprocessing, or post-processing of the digital data files. It is the responsibility of the contractor to ensure this level of compatibility.

(OPTION 1 - Add when requesting GIS-type files)

The contractor shall utilize a line-cleaning routine to assure that there are no overshoots or undershoots in the line work.

(OPTION 2 - Add when requesting scanning work).

The supplied scanned digital files shall be delivered in raster and/or vector format fully compatible with the native digital format of ____ (*insert appropriate software: i.e., Bentley Geographics; Intergraph GeoMedia Professional; ESRI ArcGIS, Autodesk Map, etc.*), version __ (*insert version used*), software.

(OPTION 3 - Add for database development).

All data generated by the contractor shall be input into a SQL compliant, relational database management system (RDBMS) database fully compatible with ____, version __ (*insert name and version of target database management system software: e.g., Oracle, IBM Informix, Microsoft Access, Microsoft SQL Server, etc.*). The database schema and structure shall comply with the most current release of the SDSFIE. All linkages of non-graphical data with graphic elements, relationships between database tables, and report formats shall be maintained.

5. MAPPING AND GIS STANDARDS.

All mapping and GIS work performed as part of this contract shall conform to the following standards for accuracy, content, and structure: All large-scale mapping projects (scales larger than 1 inch (in.) = 1,667 feet (ft.)), shall follow the Government Standards (Army, Navy, Air Force) and/or "ASPRS Accuracy Standards for Large Scale Maps" (ASPRS 1990) classification standard. Small-scale mapping (scales smaller than 1:24,000) projects will follow the OMB

“United States National Map Accuracy Standards” (Bureau of the Budget 1947).

All spatial data generated as part of this contract will conform to the most current release of the SDSFIE. The contractor shall submit a written request for approval of any deviations from the Government's established standards. No deviations from the Government's established standards will be permitted unless prior written approval of such deviation has been issued by the Government Contracting Officer.

6. REFERENCE STANDARDS/PUBLICATIONS.

6.1 CORPS OF ENGINEERS:

Mail: Corps of Engineers
Publications Depot
2803 52nd Ave.
Hyattsville, MD 20781-1102

Phone 301-394-0081/2/3
Fax 301-394-0084
DSN 290-0081/2/3

ENGINEER MANUALS

EM 1110-1-1000 (PHOTOGRAMMETRY) [FY 92]
EM 1110-1-1002 (MONUMENTATION) [FY 91]
EM 1110-1-1003 (GPS) [JUNE 91]
EM 1110-1-1004 (DEFORMATION MONITORING) [OCT 94]
EM 1110-1-1005 (TOPOGRAPHIC AND FIELD SURVEYING [FY 94]

EM 1110-2-1003 (HYDROGRAPHIC SURVEYING) [FEB 91]

EM 1110-1-1807 (CADD VOLUMES 1-4) [JULY 90]

ENGINEER REGULATIONS

ER 1110-1-1001 (USCE STANDARD SURVEY DISK) [FY 92]
ER 1110-1-1002 (MAPS & DRAWINGS) [FY 92]
ER 1130-2-307 (DREDGING POLICIES AND PRACTICES [MAY 91]

6.2 CADD/GIS TECHNOLOGY CENTER PUBLICATIONS:

Spatial Data Standard for Facilities, Infrastructure, & Environment (SDSFIE)

Via the Internet: <http://tsc.wes.army.mil>

Mail:
The CADD/GIS Technology Center
U.S. Army Engineer Research and Development Center
CEERD-ID
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
Phone: 601-634-4109 or 601-634-4582

6.3 AIR FORCE PUBLICATIONS:

6.4 NAVY PUBLICATIONS

6.5 OTHER PUBLICATIONS:

FIPS 173 Publication (U.S. Geological Survey Open File Report 88-105)

ASPRS Accuracy Standards
American Society for Photogrammetry and Remote Sensing
5410 Grosvenor Lane, Suite 210
Bethesda, MD 20814-2160

Phone: 301-493-0290
Fax: 301-493-0208
e-mail: asprs@asprs.org
Internet: <http://www.asprs.org>

7. DELIVERY MEDIA AND FORMAT.

7.1 FORMAT. A copy of all data and files developed under this contract shall be delivered to the Government in digital format _____ (*insert the appropriate submittal time: e.g., at project completion, with each submittal as required in the Schedule of Work, etc.*). All digital files shall be provided on compact disk, read-only memory (CD-ROM) in ISO-9660 format, compatible with the Government's Target GIS hardware. A "Readme.txt" file must be included with the delivered digital media that includes normal transmittal information. Use of the Internet to transfer files between the contractor and the Government is an option, as approved by the Government Contracting Officer. The digital media used shall be fully compatible with the Government's Target GIS.

7.2 LABEL. The external label for each digital media shall contain, as a minimum, the following information:

- Contract Number (and Delivery Order Number if applicable) and date.
- Format and version of operating system software.
- Name and version of utility software used for preparation (e.g., compression/decompression) (if applicable) and copying files to the media.

- Sequence number of digital media.
- List of file names on the digital media (as space on the label permits).

7.3 QUALITY ASSURANCE/QUALITY CONTROL: Before a file is placed on the delivery digital media, the following procedures shall be performed:

- a. Remove all extraneous graphics outside the border area and set the active parameters to a standard setting or those in the Government-furnished seed file.
- b. Check to ensure that all reference (or XREF) files are attached without device or directory specifications.
- c. ***(Insert one of the following statements, as applicable)***

(Option 1) All digital files shall be delivered to the Government uncompressed.

(Option 2) To the maximum extent possible, all files shall be delivered to the Government uncompressed. However, where compression of files is absolutely necessary, the digital files shall be compressed and reduced using either: (1) a self-extracting archive utility, or (2) _____ ***(insert name and version of file compression/decompression software used by Government)***, or other compatible file compression/decompression software approved by the Contracting Officer.
- d. Include all files, both graphic and nongraphic, required for the project (i.e., color tables, pen tables, font libraries, symbol libraries, user command files, plot configuration files, AML plot routines, etc.).
- e. Make sure that all support files such as those listed above are in the same directory and that references to those files do not include device or directory specifications.
- f. Include any standard sheets (i.e., abbreviation sheets, standard symbol sheets, etc.) necessary for a complete project.
- g. Document any fonts, tables, symbols, cells/blocks, line styles/types, details, reference drawings, etc., developed by the contractor, or not provided among the Government-furnished materials (GFMs). The contractor shall obtain Government approval before using anything other than the Government's standards.
- h. Each finished CADD drawing or map shall have its own separate

plot file. The plot file for each finished drawing shall be provided to the Government in a _____ (*insert name, model, and other specifications for the specific plotter configuration used by the Government target installation*) plotter configuration.

8. METADATA GENERATION.

Contractor shall provide metadata files for all geospatial and GIS data and products produced under this contract. Geospatial data are defined as information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the earth. Geospatial data affected by these requirements are those generated in a: Geographic Information System (GIS); Land Information System (LIS); Remote Sensing or Image Processing system; Computer-Aided Design and Drafting (CADD) system; Automated Mapping/Facilities Management (AM/FM) system; and other computer system that employs or references data using either absolute, relative, or assumed coordinates. The metadata file shall conform to the Spatial Data Transfer Standards (SDTS)/ Federal Information Processing Standard (FIPS) 173, Federal Geographic Data Committee (FGDC) standards, and the SDSFIE. The output from the _____ (*insert name of the metadata generator software used by the Government: e.g., Corpsmet if Corpsmet software is specified: Corpsmet software can be obtained from the Internet URL address: USACE Geospatial Data Clearinghouse Node - <http://corpsgeo1.usace.army.mil>.*) metadata generator software shall be the standard format for all metadata files created under this contract. The digital metadata files shall be provided to the Government along with each final product deliverable, unless otherwise approved in writing by the Contracting Officer.

9. TRANSMITTALS.

9.1 TRANSMITTAL LETTER: A transmittal letter containing, as a minimum, the following information shall accompany each digital media submittal to the Government. The transmittal letter shall be dated and signed by the appropriate contractor's representative. The transmittal letter shall be provided to the Government on 8-1/2-in. by 11-in. paper. A digital copy of the transmittal letter in a _____ (*insert type of format required: e.g., ASCII Text, Microsoft Word 2000/XP*) format shall also be provided on the digital media submitted to the Government.

- a. The information included on the external label of each media unit (e.g., disk, tape), along with the total number being delivered, and a list of the names and descriptions of the files on each one.
- b. Brief instructions for transferring the files from the media to the Government's target GIS.

- c. Certification that all delivery media are free of known computer viruses. A statement including the name(s) and release date(s) of the virus-scanning software used to analyze the delivery media, the date the virus scan was performed, and the operator's name shall also be included with the certification. The release or version date of the virus-scanning software shall be the current version which has detected the latest known viruses at the time of delivery of the digital media.
- d. A statement indicating that the A-E will retain a copy of all delivered digital media (with all files included) for at least one year and, during this period of time, will provide up to _____ ***(insert number of copies which may be needed: e.g., two)*** additional copies of each to the Government, if requested, at no additional cost.

9.2 ENCLOSURES OR ATTACHMENTS TO THE TRANSMITTAL LETTER: In addition, the following documentation information shall be provided to the Government on 8-1/2-in. by 11-in. paper as an enclosure or attachment to the transmittal letter provided with each digital media submittal. A digital copy of the documentation information in a _____ ***(insert type of format required: e.g., ASCII Text, Microsoft Word 2000/XP)*** format shall also be provided on the digital media submitted to the Government.

- a. Description of how the data were acquired and input into the GIS.
- b. Brief development history for each graphic and non-graphic file on the submitted digital media (e.g., content, when developed, modified, etc.).
- c. Reference files and symbols library names. A list and file location of all new symbols created for the project, which were not provided with the GFM.
- d. Level/layer assignments and lock settings (where applicable).
- e. Fonts, and line styles/types used.
- f. Metadata files in the Government-approved format.
- g. Database schema and instructions for its use. A list of all database files associated with each drawing, as well as a description of the database format and schema design.
- h. Plotting instructions on tape/diskette and paper. The plotter

configuration (e.g., name and model of plotter), pen settings, and any specific plotting instructions.

- i. A list of all deviations from the Government's specified or provided standards.
- j. A list of any non-IGES crosshatch/patterns used.
- k. Any recommended modifications necessary to make the data available for future use with a different type of GIS or with other "life-cycle" activities.

9.3 HARD COPIES OF MAPS/DRAWINGS: The Contractor shall provide _____ *(insert number of copies)* _____ *(insert either full-size or half-size)* _____ *(insert either mylar, paper, or vellum)* hard copy(ies) of each finished map/drawing with each digital media submittal to the Government.

10. OWNERSHIP.

10.1 GENERAL: The Government, for itself and such others as it deems appropriate, will have unlimited rights under this contract to all information and materials developed under this contract and furnished to the Government and documentation thereof, reports, and listings, and all other items pertaining to the work and services pursuant to this agreement including any copyright. Unlimited rights under this contract are rights to use, duplicate, or disclose text, data, drawings, and information, in whole or in part in any manner and for any purpose whatsoever without compensation to or approval from the contractor. The Government will at all reasonable times have the right to inspect the work and will have access to and the right to make copies of the above-mentioned items. All text, digital files, data, and other products generated under this contract shall become the property of the Government. By reference, the following DFAR clauses are included in this contract as a part of the requirements herein:

DFAR 252.227-7013, Rights in Technical Data – Noncommercial Items

DFAR 252.227-7028, Technical Data or Computer Software Previously Delivered to the Government

DFAR 252.227-7037, Validation of Restrictive Markings on Technical Data

DFAR 252.227-7017, Identification and Assertion of Use, Release, or Disclosure Restrictions

DFAR 252.227-7025, Limitations on the Use or Disclosure of Government-Furnished Information Marked with Restrictive Legends

DFAR 252.227-7020, Rights in Special Works

DFAR 252.227-7023, Drawings and Other Data to Become Property of Government

DFAR 252.227-7014, Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation

10.2 COPYRIGHT: Any software and computer data/information developed as a component of this contract shall have the following statement included with its documentation:

“This computer program is a work effort for the United States Government and is not protected by copyright (17 U.S. Code 105). Any person who fraudulently places a copyright notice on or does any other act contrary to the provisions of 17 U.S. Code 506(c) shall be subject to the penalties provided therein. This notice shall not be altered or removed from this software or digital media and is to be on all reproductions.”

11. GOVERNMENT-FURNISHED MATERIALS.

NOTE: Add, delete, and/or edit from the following list as required

OPTION 1: One CD-ROM of “SDSFIE, latest release.” (See section 6.2 for address to obtain information)

OPTION 2: Seed/prototype files containing the Government's preset standard settings, or workspaces (e.g., working units, color table library, line style/type library, level/layer structures, text font library, symbol cells/blocks), for use by the contractor. The seed/prototype files will be provided on _____ (insert type of digital media, e.g., 3-1/2-in. high-density floppy diskettes, CD-ROM).

OPTION 3: Reference files containing the Government's standard border sheets. Reference files will be provided on _____ (insert type of digital media).

OPTION 4: Cell/block or reference files containing the Government's standard project details on _____ (insert type of digital media).

OPTION 5: One hard copy of “_____” (insert the name of the target organization’s job-specific standards).

Appendix F

Sample Delivery Order Statement of Work (SOW) for Digital Mapping and GIS Development for a Military Installation

NOTE: The following sample SOW is included to provide guidance in the development of digital mapping and GIS development through issuance of a Delivery Order under an awarded indefinite-delivery order type A-E contract. Since the A-E contract will contain the technical clauses contained in Appendix C, it will not be necessary to repeat them in the SOW. The SOW should contain only project-specific specifications and a schedule of work. Edit as necessary for the specific type(s) of work to be performed. The information provided in bold type is to be used in filling in the blanks and should be deleted from the final contract clauses.

DELIVERY ORDER NUMBER <Insert: number of delivery order>

STATEMENT OF WORK (SOW)
FOR DIGITAL MAPPING AND GIS DEVELOPMENT
FOR <Insert: *Installation Name, State*>

<Insert: *Date*>

Contract Title: <Insert: *Contract Title*>

Delivery Order: Digital Mapping and GIS Development for
 <Insert: *Installation Name*>

Customer: <Insert: *Customer*>

1.0 INTRODUCTION

NOTE: *This appendix explains the details necessary to achieve a compatible product with the installation-specific system. It also details what is desired for scale and attributes so the product is delivered as anticipated, thereby saving time and money. The options provided herein could be performed under most GIS projects. All elements may not apply to a specific project. This description should be modified as appropriate for a specific project.*

The purpose of this appendix is to outline the tasks required for developing and providing a set of digital products containing mapping data which will be used on an interactive basis with Geographic Information System (GIS) software. Data provided to the contractor will be utilized along with data acquired by and/or generated by the contractor including computer files containing the graphic map elements and any related attribute data stored in a database management system (DBMS).

The geographic limits of the study are defined by **<Choose one: all, a portion of> the <Insert: Installation Name> <Choose: and the area around the installation as defined on Figure 1>** (Figure 1).

NOTE: *Add a figure of the geographic limits of the GIS effort.*

The following hard-copy data will be furnished by the Government to support this project: _____ **<List appropriate Government furnished items: e.g., Base TAB-Series maps at 1 in.:200 ft scale; Base TAB-Series maps at 1 in.:400 ft scale; base maps at miscellaneous scales, <Insert: and other hard-copy data>>**. The following digital data will be furnished by the Government to support this project **<List appropriate Government furnished items: e.g., AutoCAD drawing files of data, MicroStation/Intergraph design files of data, ArcInfo coverages of data, tabular database files in dBase/ Oracle/Ingress/Access/ Informix/other format, <Insert: other digital data>**.

2.0 SCOPE OF WORK

The contractor shall conduct the necessary needs analysis, data collection, database development, data upload and quality assurance, software application development, data analysis and documentation, data delivery and installation and operational instruction necessary to provide the appropriate digital mapping support required for the project.

2.1 CONDUCT NEEDS ANALYSIS

Using interviews with project personnel and personnel with appropriate technical expertise (e.g., cultural resources professionals for the upload of archaeological data), the contractor shall develop a Needs Assessment that further refines the content of the GIS study.

2.2 DEVELOP DATABASE OF EXISTING INFORMATION REQUIRED FOR DEVELOPMENT OF DIGITAL MAPPING

In accordance with *<Insert: Installation Name>* accepted technical methods, the contractor shall develop a database of existing information necessary to provide the appropriate digital mapping support required for the project, such as:

<Edit as appropriate>

- *Collection of Government-provided data (possible sources: Base Environmental Engineering Squadron, Corps of Engineers [COE]; Base Civil Engineering Squadron, Naval Public Works Center [PWC]; Contracting Office Representative [COR]).*
- *Collection of digital/hard-copy data from the base installation (possible sources: Base Environmental Engineering Squadron, Corps of Engineers [COE]; Base Civil Engineering Squadron, Naval Public Works Center [PWC]; Contracting Office Representative [COR]).*
- *Collection of digital/hard-copy data from local communities (possible sources: state, county, and city planning/GIS departments).*
- *Collection of digital/hard-copy data from appropriate agencies (possible sources: U.S. Geological Survey; U.S. Environmental Protection Agency; Bureau of Land Management; U.S. Fish and Wildlife Service; U.S. Army Corps of Engineers).*
- *Field maps by technical professionals with expertise in a given map theme (possible sources: Base Environmental Engineering Squadron; Base Civil Engineering Squadron; COR).*

2.3 DOCUMENT FILE STRUCTURES OF DATA

The contractor shall document the planned organization of the data within the file structures of the data collected. The contractor shall assess the confidence levels of the collected data and identify data gaps.

NOTE: Use Section 2.4 for installations requiring field data collection and/or verification.

2.4 FIELD DATA COLLECTION

The contractor shall conduct field data collection and verification (such as surveying, field mapping using Global Positioning System [GPS] technology) for attributes as directed by the COR or as established during any Milestone Meeting.

<Insert any details specific to your type of survey, list type of survey type >

2.5 METHODOLOGY DEVELOPMENT

The contractor shall develop a work plan and submit a methodology required for developing and providing a set of digital products containing mapping data, which will be used on an interactive basis. It shall include methods agreed upon during the data collection trip, and as approved by the COR. The contractor will submit a monthly status report. The contractor shall identify those areas that are supported by previously existing data. The methodology for developing a systematic approach to provide data starts with the data that are available and is modified accordingly to accomplish the tasks required to provide a complete and accurate database. This involves scanning before digitizing and conversions of formats before starting to develop one specific database.

2.6 DATA UPLOAD AND QUALITY ASSURANCE

The contractor shall perform data upload and quality assurance tasks including the process of entering the map and attribute data into the native software needed to support project goals. Subtasks will include one or more of the following: manual digitizing of hard-copy maps, scanning of maps and/or images, keypunch of tabular attribute data, conversion of digital data from one format to the format required by this appendix.

NOTE: Use Section 2.7 for installations requiring special GIS applications software needs.

2.7 GIS APPLICATIONS SOFTWARE DEVELOPMENT

In support of the project, applications software shall be developed as specified by the COR and discussed during the milestone meeting. Applications software development could include modifying software/user interface, integrating with other software programs, and development of software using native GIS programming language.

2.8 DATA ANALYSIS

In support of the project, the contractor shall use the data to perform analyses (such as spatial overlays, area calculations, summary statistics, etc.) as required to support technical requirements of the project.

2.9 DATA DOCUMENTATION

As defined in the Deliverables Section (Part 4 below), the data are to be documented to provide a **<Choose one or more: Data Dictionary, Data Design, User's Guide, Task Completion Report>**.

2.10 DATA DELIVERY/DATA INSTALLATION

The contractor shall deliver the data to the COR **<Choose: and loaded onto the Government's Target computer system at <Insert: location> by experienced GIS personnel>**.

2.11 SOFTWARE/DATA OPERATIONAL FAMILIARIZATION

Following data delivery and installation on the Government's Target computer system, the contractor shall provide an experienced CADD/GIS professional to provide _____ **<insert number of days>** days on-site instruction to the Government's personnel on the content, organization, accuracy, and use of the data provided.

3.0 SPECIAL CONDITIONS

3.1 RESPONSIBILITIES

3.1.1 The contractor is responsible for the accuracy, thoroughness, and scheduled progress of this work. The contractor must provide adequate personnel, plant, equipment, transportation facilities, and materials to ensure compliance with the provisions herein.

3.1.2 The contractor shall be available to participate in Technical Direction meetings/TIMs with **<Insert: Client/ Installation Organization>** to develop methodologies, review progress, discuss problem areas, and exchange information. The contractor shall also be available to respond to technical issues presented by **<Insert: Client/Installation Organization>**. For costing purposes, it is assumed that these interchanges will take place via telephone conference calls at prearranged times except for **<Choose one or more: (insert projected number of visits) site visits for data collection and methodology development, (insert projected number of visits) site visits for delivery and**

installation of draft database on Government's Target computer system, (insert projected number of visits) site visits for delivery and installation of final database on Government's Target computer system >.

3.2 SPECIAL CONSIDERATIONS

- 3.2.1** Pre-coordination of data needs or data collection trips must be accomplished through **<Insert: Client/Installation Organization>**. No contacts with Federal, state, or other agencies/groups (e.g., state, county, or city planning/GIS departments) will be made without the prior approval of the **<Insert: Client/Installation Organization>**.
- 3.2.2** All digital files, final hard-copy products, source data acquired for this project, and related materials, including that furnished by the Government, shall become the property of the **<Insert: Installation Name>** and will not be issued, distributed, or published by the contractor without specific written permission of **<Insert: Client/Installation Organization>**.
- 3.2.3** The installation will provide all necessary safety and security briefings, base permits, passes, and escorts required to conduct work on **<Insert: Installation Name>**.

All materials in each part or detail of the work shall be subject at all times to inspection by the COR. Such inspection may include plant inspection and any material furnished under this appendix.

The COR shall be allowed access to all parts of the work and shall be furnished such information and assistance from the contractor as may be required to make a complete and detailed inspection. All works which are rejected by the COR shall be corrected or, if necessary, replaced in an acceptable manner at the contractor's expense.

4.0 DELIVERABLE ITEMS

NOTE: This list of deliverable items is an extensive list that could be delivered under most CADD/GIS projects. Not all deliverables may apply to a specific project; this list should be modified as appropriate for a specific project.

4.1 MILESTONE MEETING MINUTES

The contractor shall provide milestone meeting minutes, that will include the methodology discussion and guidance received from the COR and results from data collection.

4.2 NEEDS ASSESSMENT REPORT

The contractor shall provide a letter report summarizing the results of the needs analysis task. This report should indicate the status of data needs to support the project, availability and format of existing data, data gaps, and data resolution issues.

4.3 GIS DEVELOPMENT PLAN

The contractor shall provide a GIS development plan. This plan will provide a conceptual design of the data (i.e., defining thematic map layers and associated attribute data but not providing detailed file structures, etc.) for the scope of the work to be performed. All GIS data (including geospatial data acquisition and map development for use in a GIS) shall conform to the most current release of the Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE). The most current release of the SDSFIE is available for download from the CADD/GIS Technology Center's Internet Website (<http://tsc.wes.army.mil>). All delivered digital GIS data files shall also be submitted in strict compliance with the SDSFIE for the target GIS software system.

4.4 GIS AND DATABASE

The contractor shall deliver the GIS and database in a digital format compatible with the software requirements listed herein. The data shall be provided on compact disk, read-only memory (CD-ROM) in ISO-9660 format, *<Insert: other media and other backup software>>*.

The GIS and database deliverables listed below shall be delivered to the Government formatted to be compatible with _____ *<Choose name of target GIS software: e.g., Intergraph GeoMedia; ESRI ArcGIS>*, version _____ *<insert version of target GIS software>*, _____ *(insert name of target operating system: e.g., UNIX, Microsoft Windows 2000, Microsoft Windows XP>* operating system. Database management system data shall be delivered to the Government formatted to be compatible with _____ *(insert name of target DBMS software: e.g., Microsoft Access, Oracle, IBM InFormix, Microsoft SQL Server>*, version _____ *(insert version of target DBMS software>*.

The map layers to be included in the deliverable are *(Choose one or more: planimetric data (i.e., boundaries, roads, fences, topography, buildings, (Insert: other planimetric data>), civil engineering data (i.e., pavements, other structures, utilities, (Insert: other civil engineering data>), planning data (i.e., land use, future plans, (Insert: other planning data>), environmental data (i.e., archeological resources, water resources, soils and geology, (Insert: other environmental data>), (Insert: additional*

attributes>>.

All GIS data (including geospatial data acquisition and map development for use in a GIS) shall conform to the most current release of the SDSFIE.

4.5 GIS AND DATABASE USER'S MANUAL

The contractor shall provide a User's Manual, which will document the detailed design of the GIS and database (either by providing the detailed design, or incorporation by reference, if it strictly adheres to another published design), and also provide discussion on the content of the data, and how the data can be used within the specified software package.

4.6 GIS APPLICATIONS SOFTWARE

The contractor shall deliver any GIS applications software developed under this delivery order and shall have the following attached to the documentation:

This computer program is a work effort for the United States Government and as such is not protected by copyright (17 U.S. Code 105). Any person who fraudulently places a copyright notice on, or does any other act contrary to the provisions of 17 U.S. Code 506(c) shall be subject to the penalties provided therein. This notice shall not be altered or removed from this software and is to be on all reproductions.

4.7 GIS APPLICATIONS SOFTWARE USER'S MANUAL

The contractor shall provide a GIS Applications Software User's Manual for any applications software developed under this delivery order. This manual will describe how to install the applications software on the Government's target GIS platform, and how to use the applications software. The manual will be written assuming the reader is *(Choose one: non-technical, with limited computer experience; moderately technical, with a basic understanding of the computer platform; highly experienced using similar software products>.*

4.8 HARD-COPY PRODUCTS

The contractor shall provide *<Insert number of copies>* of the following hard-copy products: *<Choose one or more: maps of all thematic layers at the following scale(s): 1":200'; 1":400'; 1":800'; 1:2,000; 1:5,000; 1:10,000; 1:24,000; fit to size (for standard engineering sizes A through E); <Insert: other hard-copy products>> on the following material(s): <Choose one or more: overhead transparency, paper, vellum, stable base material (such as mylar), <Insert: other material>>.*

4.9 DELIVERABLE SCHEDULE

- Background data collection and methodology development in support of developing and providing a set of digital products containing mapping data which will be used on an interactive basis shall begin no later than **<Insert: number of days or weeks>** following receipt of the Notice to Proceed.
- **<Insert: number of copies required>** copies of TIM minutes will be submitted no later than **<Insert: number of days or weeks>** following TIM, and are to include the data collection trip and the methodology development, as applicable.
- **<Insert: number of copies required>** copies of the Need Assessment Report shall be submitted **<Insert: number of weeks or months>** following Air Force, COE, or NAVFAC approval of the methodology.
- **<Insert: number of copies required>** copies of the Database Plan shall be submitted **<Insert: number of weeks or months>** following Air Force, COE, or NAVFAC approval of the methodology.
- The draft database shall be submitted **<Insert: number of weeks or months>** following receipt of all data necessary, approval of all methodology, and the development of all supporting software.
- **<Insert: number of copies required>** copies of the draft hard-copy products shall be submitted with the draft database.
- **<Insert: number of copies required>** copies of the Database User's Manual shall be submitted **<Insert: number of weeks or months>** following Air Force, COE, or NAVAC receipt of the draft database.
- The software shall be submitted **<Insert: number of days or weeks>** following receipt of the final database.
- **<Insert: number of copies required>** copies of the Software User's Manual shall be submitted **<Insert: number of days or weeks>** following Air Force, COE, or NAVFAC receipt of the software.
- The final database shall be submitted **<Insert: number of weeks or months>** following receipt of Air Force, COE, or NAVFAC comments on the draft database.

- *<Insert: number of copies required>* copies of the final hard-copy products shall be submitted with the final database.

Appendix G

Recommended Surveying and Mapping Criteria for Military Construction, Civil Works, Operations, Maintenance, Real Estate, and HTRW Projects

Table G1
Recommended Surveying and Mapping Criteria

Project or Activity	Equivalent Target (Plot) Map Scale ¹ SI Ratio/1 in. = x ft	Feature Location Tolerance ² mm/ft (RMS)	Horizontal Control Survey Type ³	Feature Elevation Tolerance ⁴ mm/ft (RMS)	Vertical Control Survey Type ³	Typical Contour Interval, mm/ft
MILITARY CONSTRUCTION (MCA, MCAF, OMA, OMAF):						
Design and Construction of New Facilities: Site Plan Data for Direct Input into CADD 2-D/3-D Design Files						
General Construction Site Plan Feature and Topo Detail	1:500/40 ft	100 mm/0.1-0.5 ft	3rd-I	50 mm/0.1-0.3 ft	3rd	250 mm/1 ft
Surface/Subsurface Utility Detail	1:500/40 ft	100 mm/0.2-0.5 ft	3rd-I	50 mm/0.1-0.2 ft	3rd	N/A
Building or Structure Design	1:500/40 ft	25 mm/0.05-0.2 ft	3rd-I	50 mm/0.1-0.3 ft	3rd	250 mm/1 ft
Airfield Pavement Design Detail	1:500/40 ft	25 mm/0.05-0.1 ft	3rd-I	25 mm/0.05-0.1 ft	2nd	250 mm/0.5-1 ft
Grading and Excavation Plans (Rocks, Drainage, etc.)	1:500/30-100 ft	250 mm/0.5-2 ft	3rd-I/II	100 mm/0.2-1 ft	3rd	500 mm/1-2 ft
Maintenance and Repair (M&R), or Renovation of Existing Structures, Roadways, Utilities, etc., for Design/Construction/Plans and Specifications (P&S)	1:500/30-50 ft	100 mm/0.1-0.5 ft	3rd-I	50 mm/0.1-0.5 ft	3rd	250 mm/1 ft
Recreational Site P&S (Golf Courses, Athletic Fields, etc.)	1:1000/100 ft	500 mm/1-2 ft	3rd-II	100 mm/0.2-2 ft	3rd	500 mm/2-5 ft
Training Sites, Ranges, Cantonment Areas, etc.	1:2500/100-200 ft	500 mm/1-5 ft	3rd-II	1000 mm/1-5 ft	3rd	500 mm/2 ft

(Sheet 1 of 7)

¹ Target map scale is that contained in CADD, GIS, and/or AM/FM layer, and/or to which ground topo or aerial photography accuracy specifications are developed. This scale may not always be compatible with the feature location/elevation tolerances required. In many instances, design or real property features are located to a far greater relative accuracy than that which can be scaled at the target (plot) scale, such as property corners, utility alignments, first-floor or invert elevations, etc. Coordinates/elevations for such items are usually directly input into a CADD or AM/FM database.

² The map location tolerance (or precision) of a planimetric feature is defined relative to two adjacent points within the confines of a structure or map sheet, not to the overall project or installation boundaries. Relative accuracies are determined between two points that must functionally maintain a given accuracy tolerance between themselves, such as adjacent property corners; adjacent utility lines; adjoining buildings, bridge piers, approaches, or abutments; overall building or structure site construction limits; runway ends; catch basins; levee baseline sections; etc. The tolerances between the two points are determined from the end functional requirements of the project/structure (e.g., field construction/fabrication, field stakeout or layout, alignment, locationing, etc.)

³ USACE control survey accuracy refers to the procedural and closure specifications needed to obtain/maintain the relative accuracy tolerances needed between two functionally adjacent points on the map or structure, for construction or layout. Usually Third-Order control procedures (horizontal and vertical) will provide sufficient accuracy for most work, and in many instances of small-scale mapping or GIS rasters, Third-Order, Class II methods and Fourth-Order topo/construction control methods may be used. Base- or area-wide mapping control procedures shall be designed and specified to meet functional accuracy tolerances within the limits of the structure, building, or utility distance involved for design, construction, or real estate surveys. Higher order control surveys shall not be specified for area-wide mapping or GIS definition unless a definitive functional requirement exists (e.g., military operational targeting or some low-gradient flood-control projects).

⁴ (See note 2.) Some flood-control projects may require better relative accuracy tolerances than those shown.

Table G1 (Continued)

Project or Activity	Equivalent Target (Plot) Map Scale ¹ SI Ratio/1 in. = x ft	Feature Location Tolerance, ² mm/ft (RMS)	Horizontal Control Survey Type ³	Feature Elevation Tolerance ⁴ mm/ft (RMS)	Vertical Control Survey Type ³	Typical Contour Interval mm/ft
MILITARY CONSTRUCTION (CONTINUED)						
Installation Master Planning and Facilities Management Activities (Including AM/FM and GIS Feature Applications)						
General Location Maps for Master Planning Purposes	1:5000/100-400 ft	1000 mm/2-10 ft	3rd-II	1000 mm/1-10 ft	3rd	1000 mm/2-10 ft
Space Management (Interior Design/Layout)	1:250/10-50 ft	50 mm/0.05-1 ft	Relative to Structure	N/A	N/A	N/A
Installation Surface/Subsurface Utility Maps (As-builts; Fuel, Gas, Electricity, Communications, Cable, Storm Water, Sanitary, Water Supply, Treatment Facilities, Meters, etc.)	1:1000/50-100 ft (DA) 1:500/50 ft (USAF)	100 mm/0.2 ft	3rd-I	100 mm/0.2 ft	3rd	250 mm/1 ft
Architectural Drawings: Customary Inch-Pound Scale	Equivalent SI Ratio	N/A	N/A	N/A	N/A	N/A
Site Plans: 1 in. = 20 ' (Landscape Planting Plans) 1 in. = 50 '	1:250 1:500					
Floor Plans: 1/4 in. = 1' - 0" 1/8 in. = 1' - 0" 1/16 in. = 1' - 0"	1:50 1:100 1:200					
Roof Plan: (no smaller than) 1/16" = 1' - 0"	1:200					
Exterior Elevations: 1" or 1-1/2" = 1' - 0" 1/8" = 1' - 0" 1/16" = 1' - 0"	1:10 1:100 1:200					
Interior Elevations: 1/4" = 1' - 0" 1/8" = 1' - 0"	1:50 1:100					

Table G1 (Continued)

Project or Activity	Equivalent Target (Plot) Map Scale ¹ SI Ratio/1 in. = x ft	Feature Location Tolerance, ² mm/ft (RMS)	Horizontal Control Survey Type ³	Feature Elevation Tolerance ⁴ mm/ft (RMS)	Vertical Control Survey Type ³	Typical Contour Interval mm/ft
MILITARY CONSTRUCTION (CONTINUED)						
Cross-sections: 1/4" = 1" - 0" 1/8" = 1' - 0" 1/16" = 1' - 0"	1:50 1:100 1:50					
Wall Sections: 1/2" or 3/4" = 1' - 0"	1:20					
Stair Details: 1" or 1-1/2" = 1' - 0"	1:10					
Detail Plans: 3" = 1' - 0" 1" or 1-1/2" = 1' or 0"	1:5 1:10					
Area-/Installation-/Base-Wide Mapping Control Network to Support Overall GIS and AM/FM Development ⁵	N/A	varies	3rd-I or 2nd-II	varies	2nd or 3rd	250-1000 mm 1-10 ft
Housing Management (Family Housing, Schools, Boundaries, and Other Installation Community Services)	1:5000/100-400 ft	10,000 mm/10-50 ft	4th	N/A	4th	N/A
Environmental Mapping and Assessments	1:5000/200-400 ft	10,000 mm/50-100 ft	4th	N/A	4th	N/A
Emergency Services (Military Police, Crime/Accident Locations, Emergency Transport Routes, Post Security Zoning, etc.)	1:10000/400-2000 ft	25,000 mm/50-100 ft	4th	N/A	4th	N/A
Cultural, Social, Historical (Other Natural Resources)	1:5000/400 ft	10,000mm/ 20-100 ft	4th	N/A	4th	N/A
Runway Approach and Transition Zones; General Plans/Section ⁶	1:2500/100-200 ft	2500 mm/5-10 ft	3rd-II	2500 mm/2-5 ft	3rd	1000 mm/5 ft

(Sheet 3 of 7)

⁵ GIS raster or vector features generally can be scaled or digitized from any existing map of the installation. Typically a standard USGS 1:24,000 (1 in. = 2,000 ft) scale quadrangle map is adequate given the low relative accuracies needed between GIS data features, elements, or classifications. Relative or absolute GPS positioning (1 m to 100 m) may be adequate to tie GIS features where no maps exist. In general, a basic area- or installation-wide Second- or Third-Order control network is adequate for all subsequent engineering, construction, real estate, GIS, and/or AM/FM control.

⁶ Typical requirements for general approach maps are 1:50,000 (H) and 1:1,000 (V); detail maps at 1:5,000 (H) and 1:250 (V).

Table G1 (Continued)

Project or Activity	Equivalent Target (Plot) Map Scale ¹ SI Ratio/1 in. = x ft	Feature Location Tolerance ² mm/ft (RMS)	Horizontal Control Survey Type ³	Feature Elevation Tolerance ⁴ mm/ft (RMS)	Vertical Control Survey Type ³	Typical Contour Interval, mm/ft
CIVIL WORKS DESIGN, CONSTRUCTION, OPERATIONS AND MAINTENANCE ACTIVITIES						
Site Plan for Design Memoranda, Contract Plans and Specifications, etc., for Input to CADD 2-D/3-D Design Files						
Locks, Dams, Flood Control Structures; Detail Design Plans	1:500/20-50 ft	25 mm/0.05-1 ft	2nd-II	10 mm/0.01-0.5 ft	2nd/3rd	250 mm/0.5-1 ft
Grading/Excavation Plans	1:1000/100 ft	1000 mm/0.5-2 ft	3rd-I	100 mm/0.2-1 ft	3rd	1000 mm/1-5 ft
Spillways, Concrete Channels, Upland Disposal Areas	1:1000/50-100 ft	100 mm/0.1-2 ft	2nd-II	100 mm/0.2-2 ft	3rd	1000 mm/1-5 ft
Construction In-place Volume Measurement	1:1000/40-100 ft	500 mm/0.5-2 ft	3rd-I	250 mm/0.5-1 ft	3rd	N/A
River and Harbor Navigation Projects: Site Plans, Design, Operation, or Maintenance of Flood Control Structures, Canals, Channels, etc., for Contract Plans or Reports						
Levees and Groins (New Work or Maintenance Design Drawings)	1:1000/100 ft	500 mm/1-2 ft	3rd-II	250 mm/0.5-1 ft	3rd	500 mm/1-2 ft
Canals and Waterway Dredging (New Work Base Mapping) ⁷	1:1000/100 ft	1000 mm/2 ft	3rd-II	250 mm/0.5 ft	3rd	250 mm/1 ft
Canals and Waterway Dredging (Maintenance Drawings)	1:2500/500 ft	1000 mm/2 ft	3rd-II	250 mm/0.5 ft	3rd	250 mm/1 ft
Beach Renourishment/Hurricane Protection Projects	1:1000/100-200 ft	1000 mm/2 ft	3rd-II	250 mm/0.5-1 ft	3rd	250 mm/1 ft
Project Condition Reports (Base Mapping for Plotting Hydrographic Surveys: line maps or airphoto plans)	1:2500/200-1,000 ft	10,000 mm/5-50 ft	3rd-II	250 mm/0.5-1 ft	3rd	500 mm/1-2 ft
Revetment Clearing, Grading, and As-built Protection	1:5000/100-400 ft	2500 mm/2-10 ft	3rd-II	250 mm/0.5-1 ft	3rd	500 mm/1-2 ft
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⁷ Table refers to base maps upon which subsurface hydrographic surveys are plotted, not to hydrographic survey control.

Table G1 (Continued)

Project or Activity	Equivalent Target (Plot) Map Scale ¹ SI Ratio/1 in. = x ft	Feature Location Tolerance, ² mm/ft (RMS)	Horizontal Control Survey Type ³	Feature Elevation Tolerance ⁴ mm/ft (RMS)	Vertical Control Survey Type ³	Typical Contour Interval, mm/ft
CIVIL WORKS (CONTINUED)						
Geotechnical and Hydrographic Site Investigation Surveying Accuracies for Project Construction						
Hydrographic Contract Payment and P&S Surveys	1:2500/200 ft	2000 mm/6 ft (2DRMS)	N/A	250 mm/0.5 ft	N/A	250 mm/1 ft
Hydrographic Project Condition Surveys	1:2500/200 ft	5000 mm/16 ft (2DRMS)	N/A	500 mm/1.0 ft	N/A	250 mm/1 ft
Hydrographic Reconnaissance Surveys	c	0.15 km/500 ft (2DRMS)	N/A	500 mm/1.5 ft	N/A	250 mm/1 ft
Geotechnical Investigative Core Borings/Probing/etc.	c	5000 mm/5-15 ft	4th	50 mm/0.1-0.5 ft	3rd or 4th	N/A
General Planning and Feasibility Studies, Reconnaissance Reports, Permit Applications, etc.	1:2500/100-400 ft	1000 mm/2-10 ft	3rd-II	500 mm/0.5-2 ft	3rd	1000 mm/2-10 ft
GIS Feature Mapping--Civil Works Projects Area/Project-Wide Mapping Control Network to Support Overall GIS Development	N/A	Varies 1:5000	2nd-I or 2nd-II	Varies	2nd	1000 mm/1-10 ft
Soil and Geologic Classification Maps, Well Points	1:5000/400 ft	10000 mm/20-100 ft	4th	N/A	4th	N/A
Cultural and Economic Resources, Historic Preservation	1:10,000/1000 ft	10000 mm/50-100 ft	4th	N/A	4th	N/A
Land Utilization GIS Classifications; Regulatory Permit General Locations	1:5000/400-1,000 ft	10000 mm/50-100 ft	4th	N/A	4th	N/A
Socio-economic GIS classifications	1:10,000/1000 ft	20000 mm/100 ft	4th	N/A	4th	N/A
Land Cover Classification Maps	1:5000/400-1000 ft	10000 mm/50-200 ft	4th	N/A	4th	N/A
Archeological or Structure Site Plans & Details (Including Nontopographic, Close Range, Photogrammetric Mapping)	1:10/0.5-10 ft	5 mm/0.01-0.5 ft	2nd I/II	5 mm/0.01-0.5 ft	2nd	100 mm/01-1 ft

Table G1 (Continued)

Project or Activity	Equivalent Target (Plot) Map Scale ¹ SI Ratio/1 in. = x ft	Feature Location Tolerance ² mm/ft (RMS)	Horizontal Control Survey Type ³	Feature Elevation Tolerance ⁴ mm/ft (RMS)	Vertical Control Survey Type ³	Typical Contour Interval, mm/ft
CIVIL WORKS--GIS Feature Mapping (Continued)						
Structural Deformation Monitoring Studies/Surveys⁸						
Reinforced Concrete Structures (Locks, Dams, Gates, Intake Structures, Tunnels, Penstocks, Spillways, Bridges, etc.)	Large-scale vector movement diagrams or tabulations	10 mm/0.02 ft (long-term)	N/A ⁹	2 mm/0.01 ft	N/A ⁹	N/A
Earth/Rock Fill Structures (Dams, Floodwalls, Levees, etc.) (slope/crest stability & alignment)		30 mm/0.1 ft (long-term)	N/A	15 mm/0.05 ft	N/A	N/A
Crack/joint & deflection measurements (precision micrometer)	Tabulations	0.2 mm/ 0.01 inch	N/A	N/A	N/A	N/A
Flood Control and Multipurpose Project Planning, Floodplain Mapping, Water Quality Analysis, and Flood Control Studies	1:5000/400-1000 ft	10,000 mm/20-100 ft	3rd-I	100 mm/0.2-2 ft	2nd or 3rd	1000 mm/2-5 ft
Federal Emergency Management Agency Flood Insurance Studies	1:5000/400 ft	10,000 mm/ 20 ft	3rd-I	250 mm/0.5 ft	3rd	1000 mm/4 ft
REAL ESTATE ACTIVITIES (ACQUISITION, DISPOSAL, MANAGEMENT, AUDIT¹⁰						
Tract Maps, Individual, Detailing Installation or Reservation Boundaries, Lots, Parcels, Adjoining Parcels, and Record Plats, Utilities, etc.	1:1000/50-400 ft ¹¹	10 mm/0.05-2 ft	3rd-I/II	100 mm/0.1-2 ft	3rd	1000 mm/1-5 ft
Condemnation Exhibit Maps	1:1000/50-400 ft	10 mm/0.05-2 ft	3rd-I/II	100 mm/0.1-2 ft	3rd	1000 mm/1-5 ft
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⁸ Long-term structural movements measured from points external to the structure may be tabulated or plotted in either X-Y-Z or by single vector movement normal to potential failure plane. Reference EM 1110-2-4300, EM 1110-2-1908, and EM 1110-1-1004 for stress-strain, pressure, seismic, and other precise structural deflection measurement methods within/between structural members, monoliths, cells, embankments, etc.

⁹ Accuracy standards and procedures for structural deformation surveys are contained in EM 1110-1-1004. Horizontal and vertical deformation monitoring survey procedures are performed relative to a control network established for the structure. Ties to the National Geodetic Reference System or National Geodetic Vertical Datum of 1929 are not necessary other than for general reference, and then need only USACE Third-Order connection.

¹⁰ Real property surveys shall conform to local/state minimum technical standards and/or recognized practices, and where prescribed by law or code.

¹¹ A 1:1,200 (1 in. = 100 ft) scale is recommended by USACE ER 405-1-12. Smaller scales should be on even 30-m (100-ft) increments.

Table G1 (Concluded)

Project or Activity	Equivalent Target (Plot) Map Scale ¹ SI Ratio/1 in. = x ft	Feature Location Tolerance, ² mm/ft (RMS)	Horizontal Control Survey Type ³	Feature Elevation Tolerance, ⁴ mm/ft (RMS)	Vertical Control Survey Type ³	Typical Contour Interval, mm/ft
REAL ESTATE (CONTINUED)						
Guide Taking Lines (for Fee and Easement Acquisition) Boundary Encroachment Maps	1:500/20-100 ft	50 mm/0.1-1 ft	3rd-I/II	50 mm/0.1-1 ft	3rd	250 mm/1 ft
Real Estate GIS or LIS General Feature Mapping Land Utilization and Management Forestry Management Mineral Acquisition	1:5000/200-1,000 ft	10000 mm/50-100 ft	4th	N/A	4th	N/A
General Location or Planning Maps	1:24,000 (USGS)	10000 mm/50-100 ft	N/A	5000 mm/5-10 ft	3rd	2000 mm/5-10 ft
Easement Areas and Easement Delineation Lines	1:1000/100 ft	50 mm/0.1-0.5 ft	3rd-I/II	50 mm/0.1-0.5 ft	3rd	c
HAZARDOUS, TOXIC, & RADIOACTIVE WASTE (HTRW) SITE INVESTIGATION, MODELING, AND CLEANUP						
General Detailed Site Plans (HTRW Sites, Asbestos, etc.)	1:500/5-50 ft	100 mm/0.2-1 ft	2nd-II	50 mm/0.1-0.5 ft	2nd or 3rd	100 mm/0.5-1 ft
Subsurface Geotoxic Data Mapping (Modeling)	1:500/20-100 ft	1000 mm/1-5ft	3rd-II	500 mm/1-2 ft	3rd	500 mm/1-2 ft
Contaminated Ground Water Plume Mapping (Modeling)	1:500/20-100 ft	1000 mm/2-10 ft	3rd-II	500 mm/1-5 ft	3rd	500 mm/1-2 ft
General HTRW Site Plans, Reconnaissance Mapping	1:2500/50-400	5000 mm/2-20 ft	3rd-II	1000 mm/2-20 ft	3rd	1000 mm/2-5 ft
EMERGENCY OPERATION MANAGEMENT ACTIVITIES						
(Use basic GIS database requirements defined above)						

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Appendix H

Abbreviations/Glossary

ACSM	American Congress on Surveying and Mapping
A-E	Architect-engineer firm. For the purposes of this document, the term A-E also refers to consulting firms composed of licensed surveyors and other professionals involved in the acquisition of GDS data and in the development of GDS's.
A/E/C	Architectural, Engineering, and Construction
AERMP	A-E Responsibility Management Program
ALTA	American Land Title Association
AM	Automated Mapping
AM/FM	Automated mapping/facilities management
AML	Automated macro language
ANSI	American National Standards Institute
Application	Software designed to meet software specific needs and perform specific tasks, unlike system software which runs other software.
ArcGIS	GIS software program developed by Environmental Systems Research Institute, Inc. (ESRI), registered and trademarked by ESRI.
ASCE	American Society of Civil Engineers
ASPRS	American Society for Photogrammetry and Remote Sensing

Attribute	Descriptive or characteristic information concerning a particular graphical object or entity.
AutoCAD	CADD software program developed by Autodesk, Inc., registered and trademarked by Autodesk, Inc.
Bit-mapped	Also raster image. A digital image made up of pixels (on-screen dots).
CADD	Computer-aided design and drafting
CBD	<i>Commerce Business Daily</i>
CD-ROM	Compact disk, read-only memory. A form of data storage that uses laser optics rather than magnetic means for reading data.
Cell/block	An association of elements that can be stored and placed as a group and then manipulated as a group of individual elements.
Compatible	Data that can be accessed directly by the target CADD software and platform without translation or preprocessing of data files.
CONUS	Continental United States
COR	Contracting Officer's Representative
CORS	Continuously Operating Reference Stations
CPU	Central processing unit. Refers to the computer's main processing chip, or "brain" of the machine.
Crosshatch	A specific configuration of hatch lines used to aid in delineating graphical features.
Data	Information, the components of products, and the products themselves.

Database	A collection of information organized for easy retrieval. Databases are organized into a hierarchy of files having a predetermined structure and organization that can be communicated, interpreted, or processed by a specific program.
DBMS	Database management system
DEM	Digital Elevation Model
DFAR	Defense Federal Acquisition Regulation
DFX	Drawing Exchange Format
DGPS	Digital global positioning system
Directory	A file that contains the names of other files.
Diskette	Also called floppy diskette. A flat piece of flexible plastic covered with a magnetic coating which is used to store digital data. Current sizes are 5.25 in. and 3.5 in.
DMA	Defense Mapping Agency
DoD	Department of Defense
DTM	Digital Terrain Model
EC	USACE Engineer Circular
EM	USACE Engineer Manual
EO	Executive Order
ER	USACE Engineer Regulation
FAR	Federal Acquisition Regulation
FedBizOpps	Federal Business Opportunities
FGDC	Federal Geographic Data Committee
File	A group of related information.
File format	A defined digital organization and arrangement which determines how a computer file will be written and displayed on screen or in print.

FIPS	U.S. Federal Information Processing Standards
FM	Facility Management
GeoMedia	The GIS software program developed by Intergraph, Inc., registered and trademarked by Intergraph, Inc.
GFM	Government Furnished Materials
GIS	Geographic Information System
GPS	Global Positioning System
Graphic data	Data required to display or plot a graphical entity or object.
HTRW	Hazardous, Toxic, or Radioactive Waste
IGES	Initial Graphics Exchange Specification
Informix	A relational database management system developed by Informix Software, Inc., registered and trademarked by Informix Software, Inc.
IP	Image processing
ISO	International Standards Organization
LADGPS	Local Area Differential GPS
Line style/type	A specific line pattern which type has vector properties and is used to delineate between different graphical entities which are represented by lines or polygons.
Links	An electronic relationship between similar attributes or fields in a database.
LIS	Land Information System
MGA	Modular GIS Analysis
MGE	Modular GIS Environment. The GIS software program developed by Intergraph, Inc., registered and trademarked by Intergraph, Inc.
MicroStation	The CADD software program developed by Bentley,

	Inc., registered and trademarked by Bentley, Inc.
MLLW	Mean Lower Low Water
MS-DOS	Microsoft Disk Operating System, a registered trademark of the Microsoft Corporation. Software that allows application programs to interact with the computer's hardware and translates the user's commands.
NAD	North American Datum
NAD27	North American Datum of 1927
NAD83	North American Datum of 1983
NAVD	North American Vertical Datum
NAVD88	North American Vertical Datum, 1988
NAVOCEANO	Naval Oceanographic Office
NGVD29	National Geodetic Vertical Datum 1929
NIST	National Institute of Standards and Technology
Nongraphic data	Data which provide information about a graphical entity or object, but are not required to display or plot the graphical entity or object.
NOS	National Oceanic Survey
NSDI	National Spatial Data Infrastructure
NSRS	National Spatial Reference System
OCONUS	Outside the Continental United States
ODBC	Open Database Connectivity
OMB	Office of Management and Budget
Operating system	A computer software program system which provides commands and functions used by other computer programs to communicate with the computer hardware equipment.
Oracle	A relational database management system, developed by

	Oracle Corporation, registered and trademarked by Oracle Corporation.
Origin	In coordinate geometry, the point where the x-, y-, and z-axes intersect.
Paint	A software program using pixel program (raster) images to permit electronic painting and drawing.
Path	The route consisting of drive and directory address used by the operating system to find a program or file.
Pattern	A specific configuration of lines, dots, or other graphical objects used to aid in delineating graphical features.
PC	Personal computer with an Intel, or Intel-compatible, CPU.
Pixel	Tiny dots grouped together to form the images displayed on the computer screen.
PKZIP/PKUNZIP	A shareware utility computer software program which provides for compression and decompression of programs and files.
PL	Public Law
Plane	A spatial element in geometry that may or may not have a boundary, but is level, having no elevations or depressions, and is two-dimensional.
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Plan
Relational Database System (RDBMS)	A database management system that uses SQL, the structured management query language originally developed by IBM, to implement and query data in relational tables.
Relational Interface	A generic relational database interface that isolates the differences in specific vendors' relational database management systems.
Resolution	A means for defining the sharpness or clarity of a com-

puter image made of pixels. The higher the resolution, the clearer the image.

RMSE	Root mean square error
Scanner	An electronic device which converts an image from paper into a raster image stored in an electronic computer file.
SDSFIE	Spatial Data Standard for Facilities, Infrastructure, & Environment
SDTS	Spatial Data Transfer Standard
Software	An electronic digital program which contains instructions used to perform certain tasks on a computer or to manage a computer's operation.
SOW	Statement of Work
SPCS	State Plane Coordinate System
SQL	Structured query language. Originally developed by IBM for creating, modifying, and querying relational databases. Has evolved into an ANSI, ISO, and FIPS standard.
Target	The type of computer hardware, CADD operating system software, basic system CADD software, CADD application software, and database software on which the data from a digital CADD file must be directly accessible without translation or preprocessing.
Target installation	Installation, office, or organization which will be using the CADD-generated data and files.
Text font	A specific style and size of letters, characters, and numbers.
TM	USACE Technical Manual
CGTC	CADD/GIS Technology Center
UNIX	The operating system and family of related utilities originally developed by AT&T Bell Laboratories.
USACE	U.S. Army Corps of Engineers

USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
Vector	A quantity possessing both magnitude and direction, generally represented by a line. Vectors can be manipulated geometrically and are represented as a coordinate triple (x, y, z).
WAAS	Wide Area Augmentation System
Windows	Windows operating system software, a registered trademark of the Microsoft Corporation. Software that provides a graphical interface, allowing application programs to interact with the computer hardware and translates the user's commands. Windows, version 3.1 and below, requires MS-DOS to operate.
Windows	Windows operating system, a registered trademark of the Microsoft Corporation. Software that allows application programs to interact with the PC or workstation hardware, translates the user's commands, and does not require MS-DOS to operate.
Workstation	A terminal that contains an internal CPU and can operate in a stand-alone mode or as part of a network.